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# Hazardous Waste Disposal Program Tenth Monthly Report

TRW Systems Group, Redondo Beach, Calif

Prepared for

Environmental Protection Agency, Washington, D C

13 Nov 72

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# HAZARDOUS WASTE DISPOSAL PROGRAM

## TENTH MONTHLY REPORT

CONTRACT 68-03-0089

Prepared for
the
Environmental Protection Agency

13 November 1972

TRW
SYSTEMS GROUP
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Materials handling
Storage
Surveys
Pesticides
Government policies
Drugs
Phosphoric acid
Electroplating
Metal industry
Electric batteries
Paints
Pigments
Textile industry
Leather
Tanning materials
Chemical industry
Xerography
Organic chemistry
Mercury(Metal
Process charting
Sludge disposal
Brines
Mineral deposits
Beneficiation
Smelting
Sanitary landfills
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Selenium

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# HAZARDOUS WASTE DISPOSAL PROGRAM

## TENTH MONTHLY REPORT

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# 1. INTRODUCTION

Under the requirements of Section 212 of Public Law 91-512, The Office of Solid Waste Programs of the Environmental Protection Agency is in part required to prepare "a comprehensive report and plan for the creation of a system of national disposal sites for the storage and disposal of hazardous wastes, including radioactive, toxic chemical, biological, and other wastes which may endanger public health or welfare. Such a report shall include: 1) a list of materials which should be subject to disposal in any such site; 2) current methods of disposal of such materials; 3) recommended methods of reduction, neutralization, recovery, or disposal of such materials.

Contract 68-03-0089 is the second in a series of EPA projects which are designed to provide the information required in the report to Congress. The principal objective of the current program is to define and evaluate the waste management techniques and policies currently utilized for a specified set of hazardous wastes. Waste management techniques which will be evaluated include those for storage, handling, transport, neutralization, detoxification, reuse, and disposal. Other aspects of the program include description of possible new techniques for management of hazardous wastes, proof-of-principal experimentation to determine the effectiveness of techniques for which insufficient data is available for adequate evaluation, and planning of research programs necessary for developing new procedures and processes for treating hazardous wastes for which adequate techniques do not currently exist.

The tenth monthly technical report summarizes the work performed by TRW for EPA from October 1, 1972 to October 31, 1972 under Contract 68-03-0089.

## 2. PROGRAM ACCOMPLISHMENTS

The program is divided into seven major tasks consisting of:

- Defining Adequate Waste Management. Toxicity information and toxicological standards on each hazardous material contained in lists supplied by the Solid Waste Research Office will be reviewed. Other factors (such as flammability or explosive potential) which affect the waste management process will be investigated where applicable. Acceptable criteria in terms of impact on mankind and the environment for each of the waste management steps (handling, storage, transportation, disposal, etc.) shall be defined.

- Evaluating Presently Employed Waste Management Techniques or Policies and Making Recommendations as to Adequacy. The existing techniques for waste management of each hazardous material (supplied as in Task 1) will be assessed in relation to the criteria defined in the first task. Adequate techniques shall be recommended in order of preference and any required state-of-the-art modifications prescribed. Techniques which are applicable to national disposal sites will be specified.

- Performing Field Surveys and Verification Experiments on Existing Management Procedures. In cases where adequate information to determine the effectiveness of a particular waste management technique are not available, special field surveys or verification experiments will be performed. Results of those studies will be recycled to Task 2 to complete the evaluation of the particular hazardous waste material.

- Defining, Planning and Outlining Research Programs Where Necessary for Elimination of Hazards. Where no acceptable waste management techniques currently exist for a particular hazardous waste material, efforts will be made to innovate new approaches and the necessary research and/or demonstration programs will be planned and outlined. Prioritization of the programs in terms of importance of the problem and probability of success will be accomplished.

- Conducting Proof-of-Principle Experimentation on the Most Promising Concepts. Within the constraints of schedule and budget, proof-of-principle type experimentation will be conducted on the most promising but unproven concepts.

- Determining Waste Forms. Additional information on the hazardous waste materials designated under the earlier tasks as candidates for National Disposal Sites will be collected, analyzed and presented as an integral part of this program. This information will include the forms in which the wastes are found, their location, and the quantities of waste material generated.
- Correlating Total Program Effort. The program is directed to provide inputs to a final report which will: 1) summarize the best available waste management techniques for each material; 2) list on a prioritized basis those techniques to be included at possible National Disposal Sites; and 3) indicate major gaps in current hazardous waste management technology and provide a comprehensive, prioritized research and development plan for obtaining the required technology.

During October effort was concentrated on: (1) preparation of Profile Reports; (2) determination of waste forms; (3) proof-of-principle experimentation. The progress of these efforts is summarized below.

## 2.1 PROFILE REPORT PREPARATION

During the last month, Profile Reports for one Category 1 and 201 Category 2 and 3 waste stream constituents (Table 1) were completed and are presented in Appendix A. The Category 1 report profiles sulfur mustard which was added to the list of hazardous waste materials during October. The Category 2 and 3 reports in the Appendix complete the requirements for these categories. In developing the Category 2 and 3 reports circumstances under which some of these materials might be sent to a National Disposal Site for ultimate disposal (permanent storage) were identified. For example, it is our recommendation that any antimony compound waste which cannot be economically recovered from the product of the waste treatment process be packaged and sent to a National Site.

Under the remainder of the contract the Profile Report effort will be directed at adding new information to the first draft Profile Reports which have been presented to date. Such new information will include the data on waste forms and processes required for the treatment of those forms, the addition of toxicological provisional limits where they have not been previously supplied, and the reevaluation of the waste stream constituents and their waste forms as candidates for treatment at a National Disposal Site.

## 2.2 DETERMINATION OF WASTE FORMS

In order to recommend techniques for the proper management of hazardous waste materials that are probable candidates for National Disposal Sites, it is necessary to identify the particular forms in which these wastes commonly occur, and also the locations and quantities of these waste forms. Before the bulk of the above information could be assembled through industrial and governmental contacts, however, it is important to first determine the major sources of these hazardous waste materials. A review of the California State Department of Public Health survey, the Booz-Allen report, and the Rollins Environmental Services report indicates that the environmental origins of the hazardous waste materials which are candidates for National Disposal Sites could be classified as follows:

1. Manufacturing Wastes - generated either because of its presence in the raw material, its use in the commercial production of other products, or the result of chemical reactions.

   Pharmaceutical - arsenic, mercury

   Pesticide - arsenic, mercury, lead, cadmium, organochloro and organophosphorus compounds

   Smelting and Refining of Metals - arsenic

   Metal Plating and Finishing - cadmium, chromium, copper, cyanides, fluorides

   Battery Manufacture - cadmium, lead, mercury

   Ore Extraction - cadmium, copper

   Paint and Pigments - cadmium, chromium, lead, mercury

   Textile - chromium, copper

   Leather Tanning - chromium

   Chlor-alkali - mercury

   Sodium Dichromate Manufacture - chromium

   Computer Manufacture - copper, fluorides

   Xerography - selenium

   Petroleum and Petrochemical Industry - lead, organics*

   Organic Chemical Industry - organics*

---

*Organics that are currently considered as candidates for National Disposal include acrolein, dimethyl sulfate, chloropicrin, dinitrophenol, pentachlorophenol, and polychlorinated biphenyls.

2. Residue Wastes

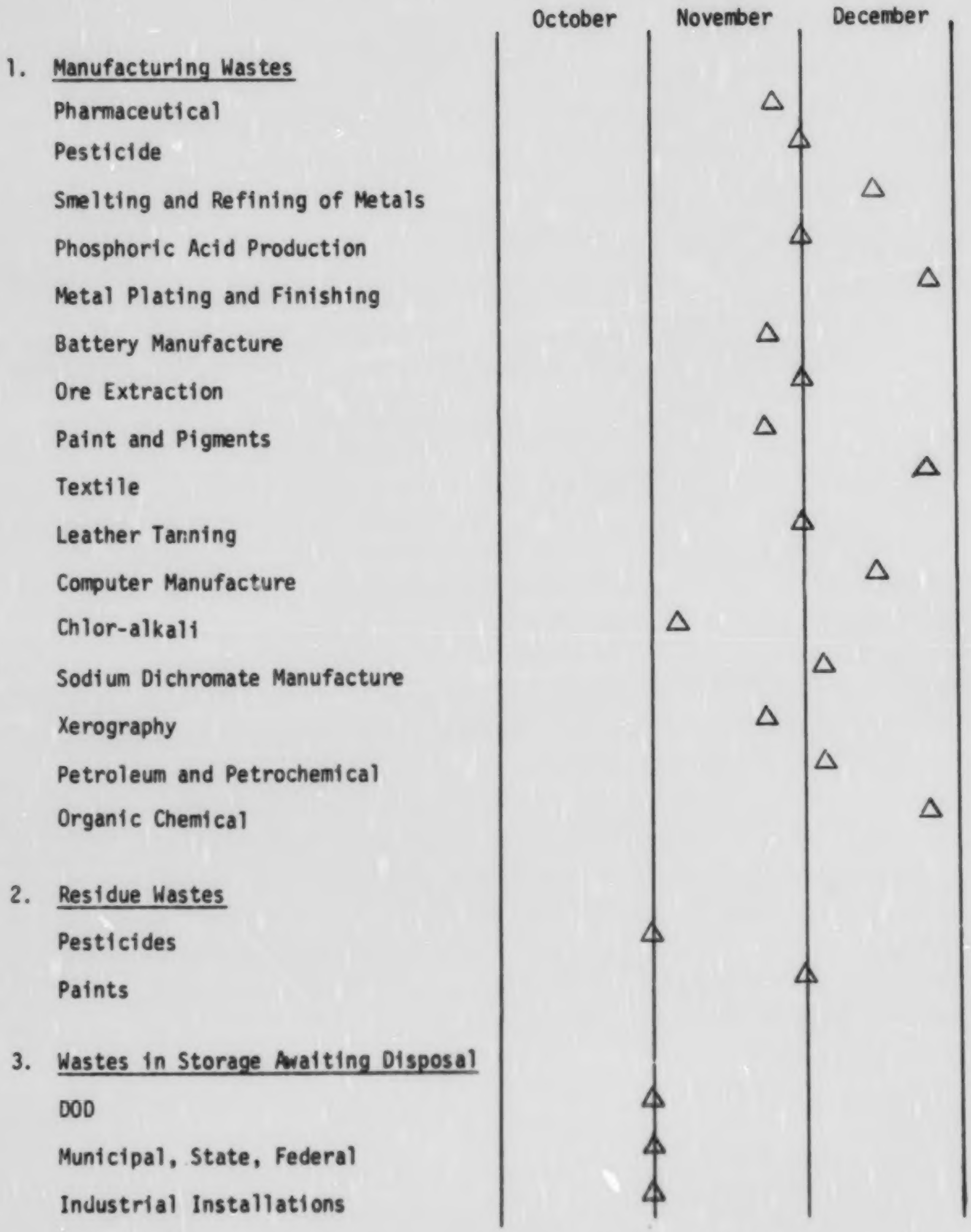
Pesticides left in "empty" containers - mostly organic pesticides wastes formulated as emulsifiable concentrates.

Old or off-specification paint discarded in containers - cadmium chromium, lead, mercury.

3. Government and Industrial Wastes in Storage Awaiting Disposal

DOD - pesticides, obsolete or overage conventional
Municipal, State and Federal Installations - pesticides
Industrial Installations - arsenic, boranes

Among the waste materials initially identified as probable candidates for National Disposal Sites, antimony, barium, beryllium, manganese, nickel, and silver compounds have been eliminated because adequate means for recovery or disposal already exist in the industries generating these types of wastes. The identification of various forms of waste which contain constituents which are candidates for National Disposal Sites has been largely completed through the subcontract with Rollins Environmental Services. Preliminary estimates on the quantities and locations of the identified waste forms have been made and were reported in the eighth monthly technical report. These estimates are currently being updated and refined by utilizing the information from the Rollins Environmental Services report and contacting various industrial plants and trade organizations. As an example of the type of information that is being developed through this effort, a report on the sources, forms, composition, and quantities of the mercury containing brine sludges from the mercury cell chlor-alkali plants has been prepared and is included in the current monthly report. A schedule for the completion of the waste form and quantities studies based on the waste generation source is presented as follows.


October
November
December
1. Manufacturing Wastes
Pharmaceutical
Pesticide
Smelting and Refining of Metals
Phosphoric Acid Production
Metal Plating and Finishing
Battery Manufacture
Ore Extraction
Paint and Pigments
Textile
Leather Tanning
Computer Manufacture
Chlor-alkali
Sodium Dichromate Manufacture
Xerography
Petroleum and Petrochemical
Organic Chemical
2. Residue Wastes
Pesticides
Paints
3. Wastes in Storage Awaiting Disposal
DOD
Municipal, State, Federal
Industrial Installations

## Mercury Containing Brine Sludges from the Mercury Cell Chlor-Alkali Plants

Approximately 25 percent of the U.S. supply of chlorine comes from mercury cells, which produce a higher grade caustic soda that is highly concentrated and essentially free of chlorine impurities. The total chlorine capacity of mercury cells in the United States is about 7,000 tons per day from 29 installations around the country*, with plant capacities ranging from 6 to about 700 tons per day. In the mercury cell process, a circulating sodium chloride solution is electrolyzed in the cell in which mercury serves as the cathode; the anode is usually graphite. Sodium ion reacts with mercury to form an amalgam, and chlorine gas is produced at the anode. The mercury flows through the cell, picking up sodium on the way, and is pumped to a regeneration cell, where the amalgam is mixed with water and forms one-half of a self-shorted electrolytic cell, with iron serving as the other electrode. The regeneration cell removes sodium from the amalgam and produces caustic soda (approximately 50 percent solution) and hydrogen gas. The regenerated mercury is then returned to the mercury cell and is vacuum de-chlorinated and then purged with air to remove the last of the chlorine. The solution is then saturated with salt, and this is followed by a purification step, in which various impurities from the newly added salt are precipitated. The brine is then passed through a filter and back to the mercury cell.

For resaturation of the partly depleted brine from electrolysis, solid salt is required by the mercury cell process. If only brine is available, this must be evaporated first to produce solid salt. Typical sources of salt include shaft mined rock salt, vacuum pan salt, solar pond salt, and salt recovered from the cell liquor evaporator in an adjacent diaphragm cell plant. The ideal raw material for the mercury cell process is, of course, highly purified recrystallized salt with a purity of 99.99 + percent NaCl.

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*Five of the installations also have diaphragm cell chlorine plants at the same location.

If the salt feed is of extremely high purity, the brine need only be filtered before returning it to the cells. If salt recovered from the diaphragm cell caustic evaporators is used, brine purification normally involves the addition of caustic soda followed by filtration, the sludge obtained is mainly graphite, along with some $CaCO_3$, $Mg(OH)_2$, and iron. When either high purity recrystallized salt or recovered salt from the diaphragm cell caustic evaporation is used, smaller quantities of mercury containing brine sludges are generated. These can often be treated and disposed of safely on the property.

If rock salt or solar salt is used, the full brine stream is treated for the removal of Mg, Fe, $CaCl_2$ and $CaSO_4$ equivalent to the pickup from the salt dissolved. Brine purification includes the addition of barium carbonate to remove sulfates, the addition of sodium carbonate or carbon dioxide to precipitate calcium, the addition of caustic soda to remove magnesium and other heavy metals, and the addition of flocculents to cause settling of the precipitates. Depending on the impurities initially present in the salt, the constituents of the brine sludge include barium sulfate, calcium carbonate, calcium sulfate, magnesium oxide, magnesium hydroxide, graphite, some iron, aluminum, mud, rocks, and typically 100 ppm mercury in the form of $HgCl_4^{=}$. Mercury losses through the brine sludges from the mercury cell chlor-alkali plants range from 0.001 to 0.04 lb per ton of chlorine produced. The mercury containing brine sludges are currently being pumped into settling basins awaiting the development and installation of adequate treatment processes.

The location, producer, chlorine production capacity, the rate of brine sludge production, and the rate of mercury loss through the brine sludges of all the 29 mercury cell chlorine plants in the United States are summarized in Table 1. In Table 2, the annual chlorine production capacity, the annual mercury loss through brine sludges, and the annual brine sludge production by state are presented. The data used in both tables were obtained through contacting chlor-alkali plants.

### TABLE 1. MERCURY LOSSES THROUGH BRINE SLUDGES FROM MERCURY CELL CHLOR-ALKALI PLANTS

| State & City | Producer | Chlorine Production Capacity (tons/day) | Source of Salt | Mercury Loss Through Brine Sludges (lb/day) | Quantity of Brine Sludges Produced (tons/day) |
|---|---|---|---|---|---|
| Alabama | | | | | |
| Le Moyne* | Stauffer Chemical Co. | 172.5 | Rock Salt | 2.0 | 10 |
| McIntosh | Olin Corp. | 350 | Rock Salt (high purity) | - | - |
| Mobile | Diamond Shamrock | 100 | Rock Salt | 0.25 - 1.50 | 2 |
| Muscle Shoals† | Diamond Shamrock | 285 | ? | 1.88 | 9.4 |
| Delaware | | | | | |
| Delaware City† | Diamond Shamrock | 400 | ? | 2.64 | 13.2 |
| Georgia | | | | | |
| Augusta† | Olin Corp. | 390 | ? | 2.52 | 12.6 |
| Brunswick | Allied Chemical Corp. | 285 | Recrystallized solar pond salt | - | - |
| Illinois | | | | | |
| East St. Louis† | Monsanta Co. | 100 | ? | 0.66 | 3.30 |
| Kentucky | | | | | |
| Calvert City | B. F. Goodrich Chemical Corp. | 330 | Rock Salt | 1.1 | 11.7 |
| Calvert City | Pennwalt Corp. | 300 | Rock Salt | 1.35 | 21 |
| Louisiana | | | | | |
| Geismar | BASF Wyandotte Corp. | 110 | recovered salt from diaphragm cell caustic liquor | 0.7 | 0.25 |
| Lake Chalres | PPG Industries, Inc. | 700 | Recovered salt from diaphragm cell caustic liquor | - | - |
| St. Gabriel* | Stauffer Chemical Co. | 520 | Rock Salt 99.1% | 1.54 | 7.7 |

TABLE 1. MERCURY LOSSES THROUGH BRINE SLUDGES FROM MERCURY CELL CHLOR-ALKALI PLANTS - CONTINUED

| State & City | Producer | Chlorine Production Capcity (tons/day) | Source of Salt | Mercury Loss Through Brine Sludges (lb/day) | Quantity of Brine Sludges Produced (tons/day) |
|---|---|---|---|---|---|
| Maine |  |  |  |  |  |
| Orrington | Sobin Chlor-Alkali Inc. | 160 | Solar pond salt | 0.18 - 0.30 | 1.50 |
| New Jersey |  |  |  |  |  |
| Linden[†] | Linden Chlorine Products | 500 | Rock Salt | 3.32 | 16.6 |
| New York |  |  |  |  |  |
| Niagara Falls[*] | Hooker Sobin Chemical | 140 | ? | 0.92 | 4.6 |
| Niagara Falls[†] | Olin Corp. | 250 | Rock salt | 1.66 | 8.3 |
| Syracuse | Allied Chemical Corp. | 250 | Recovered salt from diaphragm cell caustic liquor | - | - |
| North Carolina |  |  |  |  |  |
| Acme | Allied Chemical Corp. | 165 | Recovered salt from diaphragm cell caustic liquor | - | - |
| Pisgah[*] | Olin, Ecusta Operations | 6 | Rock Salt, 99% purity | 0.02 | 0.1 |
| Ohio |  |  |  |  |  |
| Ashtabula[*] | Detrex Chemical Industries | 60 | Mined salt, 98% purity | 0.40 | 2 |
| Tennesse |  |  |  |  |  |
| Charleston[†] | Olin Corp. | 455 | ? | 2.96 | 14.8 |
| Texas |  |  |  |  |  |
| Deer Park | Diamond Shamrock | 250 | Recovered salt from diaphragm cell caustic liquor | - | - |
| Point Comfort | Aluminum Co. of America | 400 | Evaporated salt (NaCl > 99.9%) | - | - |
| Washington |  |  |  |  |  |
| Bellingham[†] | Georgia-Pacific Corp. | 135 | Solar pond salt | 5 | 1 |
| Longview[*] | Weyerhaeuser Co. | 265 | Solar pond salt | 0.80 | 4 |

TABLE 1. MERCURY LOSSES THROUGH BRINE SLUDGES FROM MERCURY CELL CHLOR-ALKALI PLANTS

| State & City | Producer | Chlorine Production Capacity (tons/day) | Source of Salt | Mercury Loss Through Brine Sludges (lb/day) | Quantity of Brine Sludges Produced (tons/day) |
|---|---|---|---|---|---|
| West Virginia | | | | | |
| Moundsville | Allied Chemical Corp. | 250-300 | Purified evaporated salt | - | - |
| New Martinsville † | PPG Industries Inc. | 190 | ? | 1.26 | 6.3 |
| Wisconsin | | | | | |
| Port Edwards | BASF Wyandotte Corp. | 168 | 97-98% NaCl Salt from Detroit | 1.7 | 8.5 |

- Means both mercury loss and brine sludge production are negligible because highly purified salt is used.

† When insufficient data is supplied, the quantity of brine sludges produced is estimated on the basis that the salt is 98 percent NaCl. The mercury loss through brine sludges is estimated by assuming that the mercury in the brine sludges is 100 ppm.

* The mercury loss is estimated by assuming that the mercury concentration in the brine sludge is 100 ppm.

## TABLE 2. REGIONAL DISTRIBUTION OF MERCURY CONTAINING BRINE SLUDGE PRODUCTION

| State | Annual Chlorine Capacity (Tons) | Annual Mercury Loss (lb) | Annual Production of Brine Sludge (Tons) |
|---|---|---|---|
| Alabama | 331,000 | 1,964 | 7,800 |
| Delaware | 146,000 | 964 | 4,820 |
| Georgia | 250,000 | 920 | 4,600 |
| Illinois | 36,500 | 241 | 1,200 |
| Kentucky | 230,000 | 894 | 11,900 |
| Louisiana | 485,500 | 818 | 2,900 |
| Maine | 58,400 | 110 | 550 |
| New Jersey | 182,500 | 1,212 | 6,060 |
| New York | 233,600 | 942 | 4,710 |
| North Carolina | 62,400 | 7 | 40 |
| Ohio | 21,900 | 146 | 730 |
| Tennessee | 166,000 | 1,080 | 5,400 |
| Texas | 237,000 | - | - |
| Washington | 146,000 | 2,117 | 1,825 |
| West Virginia | 178,000 | 460 | 2,300 |
| Wisconsin | 61,300 | 621 | 3,100 |
| Total | 2,826,100 | 12,496 | 57,935 |

## 2.3 PROOF-OF-PRINCIPLE EXPERIMENTATION

During October effort was continued under Task 5 proof-of-principle (POP) experimentation. Two types of POP testing are now underway: arsenic removal from soil, and waste stabilization for ultimate disposal. An interim report summarizing experimental activities to date is under preparation and will be transmitted to the project officer under separate cover.

# 3. WORK PLANNED FOR NOVEMBER

During November the review and updating of the Profile Reports will be initiated. The major objectives of this effort were described in 2.1 with the exception of the activities directed towards research and development planning. In this latter area, research requirements will be identified on the basis of the Profile Report review. The effort on the waste form determination task will continue as described in Section 2.2. The proof-of-principle testing will continue on the efforts called out in Section 2.3.

# APPENDIX A - PROFILE REPORTS

## PROFILE REPORT

Acetaldehyde (1), Acetone (4), Butyraldehyde (79), Camphor (96), Crotonaldehyde (126), Cyclohexanol (133), Diisobutyl Ketone (157), Ethyl Methyl Ketone (193), Furfural (203), Isophorone (226), Mesityl Oxide (259), Methyl Isobutyl Ketone (271), Paraformaldehyde (320), Propionaldehyde (355).

## 1. GENERAL

### Introduction

The aliphatic carbonyl compounds treated in this report have all been selected as probable candidates for municipal disposal. These materials are similar in that most are commodity chemicals with relatively low toxicity, well-defined and safe methods of industrial handling and common methods of disposal. The aliphatic carbonyl compounds are, therefore, discussed as a class in this report.

### Manufacture and Use

These aliphatic aldehydes and ketones are manufactured by a variety of industrial processes. In general, the synthetic routes employed involve some form of catalytic oxidation or dehydration of the corresponding alcohol. They are used as solvents and/or intermediates in the manufacture of chemicals and synthetic resins. Some (e.g., furfural and isophorone) are themselves components of important commercial polymers.

### Physical and Chemical Properties

The physical and chemical properties of the compounds discussed in this report are included in the attached worksheets.

## 2. TOXICOLOGY[0766]

As a group, the aliphatic carbonyl compounds possess narcotic and anesthetic properties, but this is obscured in many cases by their highly irritating action on the eyes and the mucous membranes of the respiratory tract. The more volatile compounds which are very soluble in water act chiefly on the eyes and tissues of the upper respiratory tract, while the less volatile and water soluble compounds tend to penetrate more deeply into the respiratory system and may affect the lungs. These effects range from slight, as in the case of acetone, to substantial, as in the case of the unsaturated aldehydes and ketones such crotonaldehyde, furfural, isophorone and mesityl oxide. In general, the danger parallels the TLV's that have been established for these materials. Ingestion, aside from its irritating effect, causes nausea, vomiting, headache and dizziness. None of these compounds has been shown to have a high degree of chronic toxicity except for the unsaturated aldehydes and ketones which may be dangerous to the kidneys, liver and lungs.

The Threshold Limit Values (TLV) and Maximum Allowable Concentrations (MAC) that have been established are:

| Substance | TLV | | MAC |
|---|---|---|---|
| | ppm | mg/M$^3$ | ppm |
| Acetaldehyde | 100 | 180 | 200 |
| Acetone | 1000 | 2400 | 1000 |
| Butyraldehyde | | | |
| Camphor | | | |
| Crotonaldehyde | 2 | 6 | |
| Cyclohexane | 50 | 200 | 50 |
| Diisobutyl Ketone | 25 | 150 | 50 |
| Ethyl Methyl Ketone | 200 | 590 | 250 |
| Furfural | 5 | 20 | 5 |
| Isophorone | 10 | 55 | |
| Mesityl Oxide | 25 | 100 | 25 |
| Methyl Isobutyl Ketone | 100 | 410 | 100 |
| Paraformaldehyde | | | |
| Propinaldehyde | | | |

## 3. OTHER HAZARDS

All of these materials must be considered as potential fire hazards. The severity of the threat they pose increases with decreasing boiling point; the precise values for their flash points and other pertinent data may be found in the attached worksheets.

# 4. DEFINITION OF WASTE MANAGEMENT PRACTICES

## Handling, Storage and Transportation

The aliphatic carbonyl compounds treated in this report are all toxic to a certain extent due to the narcotic effects of high concentrations and irritating effects of the liquids or vapors, especially in the sensitive areas of the eyes, mucous membranes and respiratory tract. Thus, they should be handled in a well-ventilated area and protective clothing and respirators are recommended where necessary. In cases of accidental contact, all contaminated clothing should be removed and the skin washed thoroughly with soap and water.

These materials are shipped under a variety of U.S. Department of Transportation, Coast Guard and IATA regulations. Most regulations relate to the flammability of these compounds. Information on safe handling and use of these compounds can be found in standard reference sources or manufacturers' Technical Data Sheets.

## Disposal/Reuse

Manufacturers who use these aldehydes and ketones as chemical intermediates or process solvents recycle as much material as possible. However, a substantial amount of the compounds in this group are used to produce resins or plastics and are generally not recoverable from these applications.

Many of the various manufacturing processes result in dilute waste streams which have a high chemical and biological oxygen demand.[0285,1543] They can be treated on site or discharged into the municipal sewers.

Recommended air and water standards are listed below. The air standard is .01 TLV and the water standard is .01 TLV by weight in 2 liters of water in the absence of independent data. No standards have been recommended for compounds for which TLV's have not been established.

| Substance | Limit for Air (Man) ppm | Limit for Air (Man) mg/M$^3$ | Limit for Water (Man) ppm | Limit for Water (Fish) ppm |
|---|---|---|---|---|
| Acetaldehyde | 1.0 | 1.8 | 9.0 | 5.3 |
| Acetone | 10 | 24 | 60.0 | 1300 |
| Butyraldehyde | | | | 0.1 - 10 |
| Camphor | | | | |
| Crotonaldehyde | 0.02 | 0.06 | 0.30 | 0.1 - 10 |
| Cyclohexane | 0.50 | 2.0 | 10.0 | 0.1 - 10 |
| Diisobutyl Ketone | 0.25 | 1.5 | 7.5 | 10 - 100 |
| Ethyl Methyl Ketone | 2 | 5.9 | 29.5 | 340 |
| Furfural | 0.05 | 0.20 | 1.0 | 0.12 |
| Isophorone | 0.10 | 0.55 | 2.75 | 0.1 - 10 |
| Mesityl Oxide | 0.25 | 1.0 | 5.0 | 0.1 - 10 |
| Methyl Isobutyl Ketone | 1 | 4.1 | 20.5 | 100 - 100 |
| Paraformladehyde | | | | |
| Propinaldehyde | | | | |

## 5. EVALUATION OF WASTE MANAGEMENT PRACTICES

### Option No.1 - Recycling

Manufacturers that use these materials as chemical intermediates or process solvents recycle as much material as possible. In addition, a certain amount of contaminated material may be reprocessed. This is the method of choice wherever possible.

### Option No.2 - Treatment of Waste Water to Reduce Chemical and Biological Oxygen Demand

Aldehydes and ketones treated in this report not only have a very low level of toxicity but they can be biodegraded very rapidly by unacclimated activated sludges.[1543] This is due in part to the fact that they can, in most cases, be simply oxidized by chemical or biological means to acids that are the same or very similar to carboxylic acids present in normal sewage.

Thus, the best method of disposal is via municipal sewage treatment plants, provided the rate of discharge is uniform.

### Option No.3 - Incineration

Bulk quantities of contaminated aliphatic aldehydes and ketones that can not be reprocessed or released by controlled dilution can best be disposed of by incineration. This is the method of choice where adequate biological treatment facilities are not available.

## 6. APPLICABILITY TO NATIONAL DISPOSAL SITES

All of the wastes generated by the industries that produce and use the materials treated in this report can be handled by municipal disposal either by sewage treatment or incineration. Disposal is so easy and safe that use of facilities at the National Disposal Sites need not be considered.

# 7. REFERENCES

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0766 Sax, I.R., Dangerous properties of industrial materials. 3d ed. New York, Reinhold Publishing Corporation, 1968. 1,251 p.

1492 The Merck index of chemicals and drugs. 7th ed. Rahway, New Jersey, Merck Company, Inc., 1960. 1,634 p.

1543 Ludzack, F.J., M.B. Ettinger. Chemical structures resistant to aerobic chemical stabilization. Journal Water Pollution Control Federation, 32(11):1173-1200, Nov. 1960.

1570 Weast, E.C., ed. Handbook of chemistry and physics. 48th ed. Cleveland, Ohio, Chemical Rubber Company, 1969. 2,100 p.

1

## HAZARDOUS WASTES PROPERTIES WORKSHEET

H. M. Name Acetaldehyde

IUC Name ethanol

Common Names acetic aldehyde, ethyl aldehyde

Structural Formula

$CH_3$-CHO

Molecular Wt. 44.05 Melting Pt. -123.5 C(1) Boiling Pt. 20.8 C(1)

Density (Condensed) 0.7827 @ 20/20 C(1) Density (gas) 1.52(1) @

Vapor Pressure (recommended 55 C and 20 C)

@ @ @

Flash Point -36 F (C.C.)(1) Autoignition Temp. 365 F(1)

Flammability Limits in Air (wt %) Lower Upper

Explosive Limits in Air (wt. %) Lower 4.0%(1) Upper 57%(1)

Solubility

Cold Water miscible(2) Hot Water Ethanol miscible(2)

Others:

Acid, Base Properties

Highly Reactive with

Compatible with

Shipped in

ICC Classification Flammable liquid, red label Coast Guard Classification red label

Comments

References (1) 0766
(2) 1492

HAZARDOUS WASTES PROPERTIES
WORKSHEET

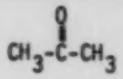
4

H. M. Name Acetone

IUC Name 2-propanal

Common Names dimethyl ketone, propanone

Structural Formula



$CH_3-\overset{\overset{O}{\|}}{C}-CH_3$

Molecular Wt. 58.08 Melting Pt. -94.6 C(1) Boiling Pt. 56.48 C(1)

Density (Condensed) 0.7972 @ 15 C(1) Density (gas) 2.00(1) @

Vapor Pressure (recommended 55 C and 20 C)

400 mm @ 39.5 C(1) @ @

Flash Point 0 F (C.C.)(1) Autoignition Temp. 1000 F(1)

Flammability Limits in Air (wt %) Lower Upper

Explosive Limits in Air (wt. %) Lower 2.6%(1) Upper 12.8%(1)

Solubility

Cold Water miscible(2) Hot Water Ethanol miscible(2)

Others: miscible DMF, chloroform, ether(2)

Acid, Base Properties

Highly Reactive with

Compatible with

Shipped in

ICC Classification Flammable liquid, red label Coast Guard Classification red label

Comments MCA warning label

References (1) 0766
(2) 1492

## HAZARDOUS WASTES PROPERTIES
## WORKSHEET

79

H. M. Name Butyraldehyde

IUC Name 1-butanal

Common Names n-butyl aldehyde

Structural Formula

$CH_3$-$CH_2$-$CH_2$-CHO

Molecular Wt. 72.1 Melting Pt. -100 C(1) Boiling Pt. 75.7 C(1)

Density (Condensed) 0.817 @ 20/4 C(1) Density (gas) 2.5(1) @

Vapor Pressure (recommended 55 C and 20 C)

@ @ @

Flash Point 20 F (C.C.)(1) Autoignition Temp. 446 F(1)

Flammability Limits in Air (wt %) Lower Upper

Explosive Limits in Air (wt. %) Lower Upper

**Solubility**

Cold Water Hot Water Ethanol

Others: miscible ethyl acetate, acetone, many other organic solvents.(2)

Acid, Base Properties

Highly Reactive with

Compatible with

Shipped in

ICC Classification Flammable liquid, red label Coast Guard Classification red label

Comments MCA warning label

References (1) 0766

## HAZARDOUS WASTES PROPERTIES
## WORKSHEET

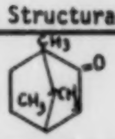
96

H. M. Name Camphor

IUC Name

Common Names 2-camphonone, gum camphor, laurel camphor

Structural Formula



Molecular Wt. 152.23 Melting Pt. 174-177 C(1) Boiling Pt. 204 C(1)

Density (Condensed) 0.992 @ 25/4 C(1) Density (gas) 5.24(1) @

Vapor Pressure (recommended 55 C and 20 C)

@ @ @

Flash Point 150 F (C.C.)(1) Autoignition Temp. 871 F(1)

Flammability Limits in Air (wt %) Lower Upper

Explosive Limits in Air (wt. %) Lower 0.6%(1) Upper 3.5%(1)

Solubility

Cold Water 1 g/800 ml at 25 C(2) Hot Water Ethanol very soluble(2)

Others: soluble chloroform, benzene, acetone, acetic acid, and most other common solvents.(2)

Acid, Base Properties

Highly Reactive with $KMnO_4$

Compatible with

Shipped in

ICC Classification Coast Guard Classification Hazardous article

Comments sublimes at room temperature and atmospheric pressure.(2)

References (1) 0766

126

## HAZARDOUS WASTES PROPERTIES
## WORKSHEET

H. M. Name Crotonaldehyde

IUC Name 2-butenal

Common Names crotonic aldehyde, β-methylarolein

Structural Formula

$CH_3$-CH=CH-CHO

Molecular Wt. 70.09 Melting Pt. ______ Boiling Pt. 104 C(1)

Density (Condensed) 0.853 @ 20/20 C(1) Density (gas) 2.41(1) @ ______ ______

Vapor Pressure (recommended 55 C and 20 C)

______ @ ______ ______ @ ______ ______ @ ______

Flash Point 55 F(1) Autoignition Temp. ______

Flammability Limits in Air (wt %) Lower ______ Upper ______

Explosive Limits in Air (wt. %) Lower 2.1%(1) Upper 15.5%(1)

Solubility

Cold Water 18.1 g/l at 20 C(1) Hot Water ______ Ethanol miscible

Others: ______

Acid, Base Properties ______

Highly Reactive with ______

Compatible with ______

Shipped in ______

ICC Classification Flammable liquid, red label Coast Guard Classification red label

Comments readily resinifies to a dimer when pure; usually stabilized with 7% water.

References (1) 1492

## HAZARDOUS WASTES PROPERTIES WORKSHEET

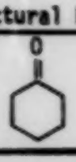
133

H. M. Name Cyclohexanone

IUC Name cyclohexanone

Common Names

Structural Formula



Molecular Wt. 98.14 Melting Pt. -45.0 C(1) Boiling Pt. 155.6 C(1)

Density (Condensed) 0.9478 @ 20/4 C(1) Density (gas) 3.4(1) @

Vapor Pressure (recommended 55 C and 20 C)

10 mm @ 38.7 C(1) @ @

Flash Point 111 F(1) Autoignition Temp. 788 C(1)

Flammability Limits in Air (wt %) Lower Upper

Explosive Limits in Air (wt. %) Lower 1.1% (1000 C)(1) Upper

Solubility

Cold Water 3.6 wt.% at 20 C(1) Hot Water Ethanol miscible(2)

Others: miscible ethyl acetate, petroleum solvents, aromatic hydrocatbons.(2)

Acid, Base Properties neutral

Highly Reactive with

Compatible with

Shipped in

ICC Classification Coast Guard Classification

Comments MCA warning label

References

## HAZARDOUS WASTES PROPERTIES WORKSHEET

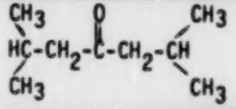
157

H. M. Name Diisobutylketone

IUC Name 2,6-dimethyl-4-heptanone

Common Names isovalerone

Structural Formula



$$\mathrm{(CH_3)_2HC{-}CH_2{-}\overset{O}{\overset{\|}{C}}{-}CH_2{-}CH(CH_3)_2}$$

Molecular Wt. 142.2 Melting Pt. ______ Boiling Pt. 166 C(1)

Density (Condensed) 0.81(1) @ ______ Density (gas) 4.9(1) @ ______

Vapor Pressure (recommended 55 C and 20 C)

______ @ ______ ______ @ ______ ______ @ ______

Flash Point 104 F(1) Autoignition Temp. ______

Flammability Limits in Air (wt %) Lower ______ Upper ______

Explosive Limits in Air (wt. %) Lower 0.8% at 212 F(1) Upper 6.2% at 212 F(1)

Solubility

Cold Water ______ Hot Water ______ Ethanol ______

Others: ______

Acid, Base Properties ______

Highly Reactive with ______

Compatible with ______

Shipped in ______

ICC Classification ______ Coast Guard Classification ______

Comments MCA warning label

References (1) 0766

193

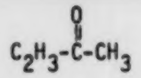
## HAZARDOUS WASTES PROPERTIES
## WORKSHEET

H. M. Name: Ethyl Methyl Ketone

IUC Name: 2-butanone

Common Names: methyl ethyl ketone; MEK

Structural Formula



$C_2H_3-\overset{\overset{O}{\|}}{C}-CH_3$

Molecular Wt. 72.10    Melting Pt. -85.9 C(1)    Boiling Pt. 79.57 C(1)

Density (Condensed) 0.80615 @ 20/20 C(1)    Density (gas) 2.41(1) @

Vapor Pressure (recommended 55 C and 20 C)

71.2 mm @ 20 C(1)    @    @

Flash Point 22 F (T.O.C.)(1)    Autoignition Temp. 960 F(1)

Flammability Limits in Air (wt %)    Lower    Upper

Explosive Limits in Air (wt. %)    Lower 1.8%(1)    Upper 10%(1)

**Solubility**

Cold Water    Hot Water    Ethanol

Others:

Acid, Base Properties

Highly Reactive with

Compatible with

Shipped in

ICC Classification: Flammable liquid, red label    Coast Guard Classification: red label

Comments

References (1) 0766

HAZARDOUS WASTES PROPERTIES
WORKSHEET

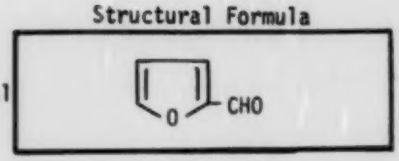
203

H. M. Name Furfural

IUC Name

Common Names 2-furancarbonal, 2-furaldehyde; fulale; fural

Structural Formula



Molecular Wt. 96.1 Melting Pt. -36.5 C(1) Boiling Pt. 161.7 C(1)

Density (Condensed) @ Density (gas) @

Vapor Pressure (recommended 55 C and 20 C)

@ @ @

Flash Point 140 F (C.C.)(1) Autoignition Temp. 600 F(1)

Flammability Limits in Air (wt %) Lower Upper

Explosive Limits in Air (wt. %) Lower 2.1% at 125 C(1) Upper

Solubility

Cold Water soluble(2) Hot Water Ethanol very soluble(2)

Others: very soluble ether(2)

Acid, Base Properties

Highly Reactive with

Compatible with

Shipped in

ICC Classification Coast Guard Classification

Comments

References (1) 0766
(2) 1492

HAZARDOUS WASTES PROPERTIES
WORKSHEET

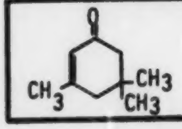
226

H. M. Name Isophorone

IUC Name 3,5,5-trimethyl-2-cyclohexenone

Common Names

Structural Formula



Molecular Wt. 138.1 Melting Pt. Boiling Pt. 215.2 C(1)

Density (Condensed) 0.9229 @ Density (gas) 4.77(1) @

Vapor Pressure (recommended 55 C and 20 C)

1 mm @ 38.0 C(1) @ @

Flash Point 205 F (O.C.)(1) Autoignition Temp. 864 F(1)

Flammability Limits in Air (wt %) Lower Upper

Explosive Limits in Air (wt. %) Lower 0.8%(1) Upper 3.8%(1)

Solubility

Cold Water insoluble Hot Water Ethanol soluble

Others:

Acid, Base Properties

Highly Reactive with

Compatible with

Shipped in

ICC Classification Coast Guard Classification

Comments

References (1) 0766

271

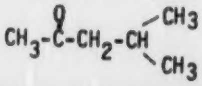
## HAZARDOUS WASTES PROPERTIES WORKSHEET

H. M. Name Methyl Isobutyl Ketone

IUC Name 2-methyl-2-pentanone

Common Names hexone, isopropylacetone

Structural Formula



$CH_3-\overset{O}{\overset{\|}{C}}-CH_2-CH\begin{smallmatrix}CH_3\\CH_3\end{smallmatrix}$

Molecular Wt. 100.2 Melting Pt. -80.3 F(1) Boiling Pt. 118 C(1)

Density (Condensed) 0.803(1) @ Density (gas) 3.45(1) @

Vapor Pressure (recommended 55 C and 20 C)

16 mm @ 20 C(1) @ @

Flash Point 73 F(1) Autoignition Temp. 858 F(1)

Flammability Limits in Air (wt %) Lower Upper

Explosive Limits in Air (wt. %) Lower 1.3% at 122 F(1) Upper 8.0% at 212 F(1)

Solubility

Cold Water slightly Hot Water Ethanol soluble

Others:

Acid, Base Properties

Highly Reactive with

Compatible with

Shipped in

ICC Classification Coast Guard Classification

Comments

References (1) 0766

259

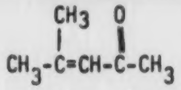
## HAZARDOUS WASTES PROPERTIES WORKSHEET

H. M. Name Mesityl Oxide

IUC Name 4-methyl-3-penten-2-one

Common Names

Structural Formula



$CH_3-\overset{\overset{CH_3}{|}}{C}=CH-\overset{\overset{O}{\|}}{C}-CH_3$

Molecular Wt. 98.14 Melting Pt. -59 C(1) Boiling Pt. 130.0 C(1)

Density (Condensed) 0.8539 @ 20/4 C(1) Density (gas) 3.38(1) @

Vapor Pressure (recommended 55 C and 20 C)

10 mm @ 26.0 C(1) @ @

Flash Point 90 F (C.C.) Autoignition Temp. 652 F(1)

Flammability Limits in Air (wt %) Lower Upper

Explosive Limits in Air (wt. %) Lower Upper

Solubility

Cold Water 3 wt.%(2) Hot Water Ethanol miscible(2)

Others: miscible most organic liquids.(2)

Acid, Base Properties

Highly Reactive with

Compatible with

Shipped in

ICC Classification Coast Guard Classification

Comments

References (1) 0766
(2) 1492

## HAZARDOUS WASTES PROPERTIES
## WORKSHEET

320

H. M. Name Paraformaldehyde

IUC Name ______

Common Names trioxymethylene, paraform trioxane

Structural Formula

$(CH_2O)_xHOH$

Molecular Wt. ______ Melting Pt. 120-160 C(1) Boiling Pt. decomposed to formaldehyde

Density (Condensed) 1.39(1) @ ______ Density (gas) ______ @ ______

Vapor Pressure (recommended 55 C and 20 C)

1.45 mm @ 25 C(1) ______ @ ______ ______ @ ______

Flash Point 158 F(1) Autoignition Temp. 572 F(1)

Flammability Limits in Air (wt %) Lower ______ Upper ______

Explosive Limits in Air (wt. %) Lower ______ Upper ______

Solubility

Cold Water slowly soluble(2) Hot Water soluble(2) Ethanol insoluble(2)

Others: ______

Acid, Base Properties ______

Highly Reactive with ______

Compatible with ______

Shipped in ______

ICC Classification ______ Coast Guard Classification ______

Comments MCA warning label

References (1) 0766
(2) 1492

355

HAZARDOUS WASTES PROPERTIES
WORKSHEET

H. M. Name Propionaldehyde

IUC Name propanal

Common Names propyl aldehyde

Structural Formula

$CH_3$-$CH_2$-CHO

Molecular Wt. 58.1 Melting Pt. -81 C(1) Boiling Pt. 48 C(1)

Density (Condensed) 0.807 @ 20/4 C(1) Density (gas) 2.0(1) @

Vapor Pressure (recommended 55 C and 20 C)

@ @ @

Flash Point 15-19 F (O.C.)(1) Autoignition Temp.

Flammability Limits in Air (wt %) Lower Upper

Explosive Limits in Air (wt. %) Lower 3.7%(1) Upper 16.1%(1)

Solubility

Cold Water 20 vol.% at 20 C(2) Hot Water Ethanol miscible(2)

Others: miscible ether(2)

Acid, Base Properties

Highly Reactive with

Compatible with

Shipped in

ICC Classification Coast Guard Classification

Comments

References (1) 0766

(2) 1492

# PROFILE REPORT
# ALIPHATIC AND AROMATIC CARBONYL COMPOUNDS AND DERIVATIVES

Acetic Acid (2), Acetic Anhydride (3), Acetyl Chloride (9), Formaldehyde (301), Oleic Acid (316), Phthalic Anhydride (337), Sodium Formate (390), Sodium Oxalate (398)

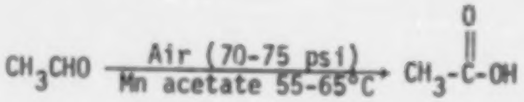
## 1. GENERAL

### Introduction

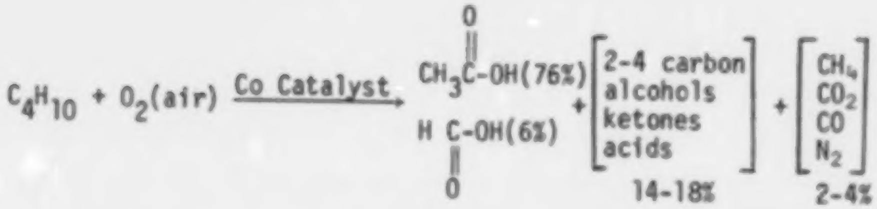
The aliphatic and aromatic carbonyl compounds and their derivatives treated in this report all have been selected as probable candidates for industrial disposal. These materials are similar in that most are commodity chemicals with many common chemical characteristics and well-defined and safe methods of industrial handling and common methods of waste disposal.

### Manufacture and Use

Acetic acid is presently manufactured from acetyldehyde by catalytic oxidation in either batch, continuous batch or gas phase processes (Equation 1); by catalytic gas phase oxidation of butane (Equation 2); or by the destructive distillation of wood.[1501]



$$CH_3CHO \xrightarrow[\text{Mn acetate } 55\text{-}65^\circ C]{\text{Air (70-75 psi)}} CH_3\text{-}\overset{\overset{O}{\|}}{C}\text{-OH} \qquad (1)$$

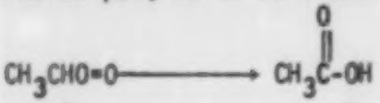


$$C_4H_{10} + O_2(\text{air}) \xrightarrow{\text{Co Catalyst}} \begin{matrix} CH_3\overset{\overset{O}{\|}}{C}\text{-OH}(76\%) \\ H\ \underset{\underset{O}{\|}}{C}\text{-OH}(6\%) \end{matrix} + \underset{14\text{-}18\%}{\begin{bmatrix}\text{2-4 carbon}\\ \text{alcohols}\\ \text{ketones}\\ \text{acids}\end{bmatrix}} + \underset{2\text{-}4\%}{\begin{bmatrix}CH_4\\ CO_2\\ CO\\ N_2\end{bmatrix}} \qquad (2)$$

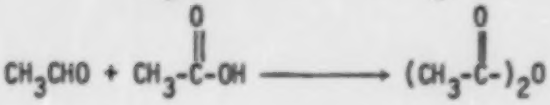
Acetic acid is used to make cellulose acetate (via acetic anhydride) (47%), vinyl acetate (25%) and other acetates (16%). Miscellaneous uses account for 12 percent of the volume.[1506]

Acetic anhydride is manufactured by the reaction of acetyldehyde with acetic acid, which is made *in situ* by the catalytic oxidation of acetyldehyde (Equations 3,4) or by the reaction of acetic acid with ketene which is produced by cracking of acetic acid (Equations 5,6).

From acetyldehyde at 60 psi, 50 to 70 C and Co-Mn acetate catalyst:

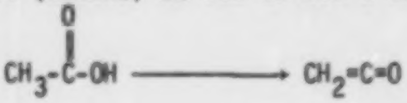


$$CH_3CHO{=}O \longrightarrow CH_3\overset{\overset{O}{\|}}{C}{-}OH \qquad (3)$$

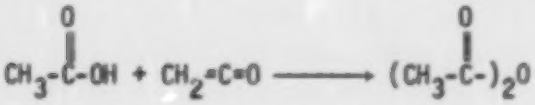


$$CH_3CHO + CH_3{-}\overset{\overset{O}{\|}}{C}{-}OH \longrightarrow (CH_3{-}\overset{\overset{O}{\|}}{C}{-})_2O \qquad (4)$$

From acetic acid (ketene) at 700 to 800 C and 200 mm:



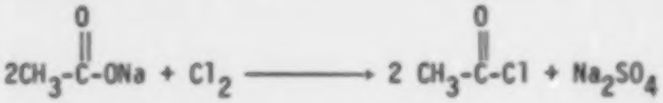
$$CH_3{-}\overset{\overset{O}{\|}}{C}{-}OH \longrightarrow CH_2{=}C{=}O \qquad (5)$$



$$CH_3{-}\overset{\overset{O}{\|}}{C}{-}OH + CH_2{=}C{=}O \longrightarrow (CH_3{-}\overset{\overset{O}{\|}}{C}{-})_2O \qquad (6)$$

The main uses for acetic anhydride are the production of cellulose acetate (90%), vinyl acetate (5%), aspirin (1%) and all others (5%).[1506]

Acetyl chloride is made by treating sulfur dioxide and chlorine with sodium acetate followed by distillation. When used *in situ* as a catalyst, it is prepared by treating acetic anhydride with hydrogen chloride at 85 to 90 C.[1433]



$$2CH_3{-}\overset{\overset{O}{\|}}{C}{-}ONa + Cl_2 \longrightarrow 2\ CH_3{-}\overset{\overset{O}{\|}}{C}{-}Cl + Na_2SO_4$$

Acetyl chloride is used on a large scale as a catalyst in the chlorination of acetic acid, as an acetylating agent in organic synthesis and in the preparation of anhydrides of carboxylic acids.[1433]

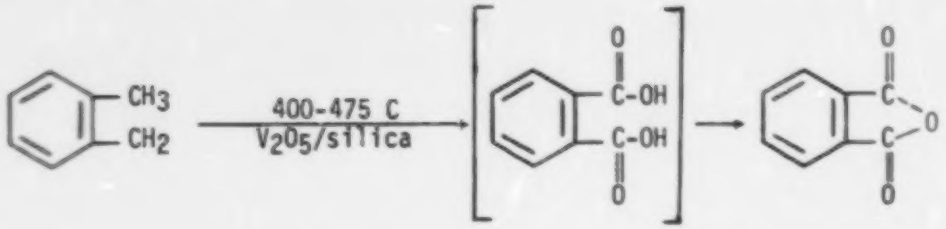
Formaldehyde is produced by the catalytic oxidation of methanol at 300 to 650 C using a silver-copper or iron-molybdenum-vanadium catalyst. Gaseous formaldehyde readily polymerizes and, for this reason, is sold only as aqueous solutions in which it is stable.[1433,1501]

$$CH_3OH + O_2(air) \longrightarrow CH_2O + H_2O$$

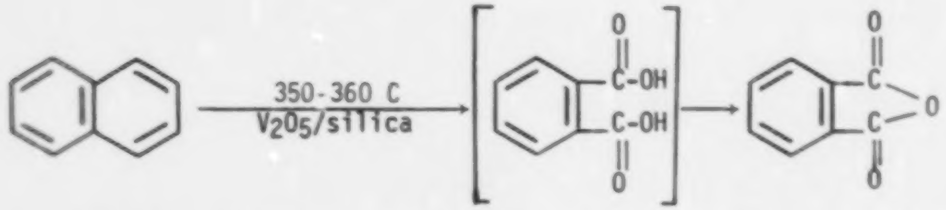
Formaldehyde is used to make resins (60%), pentaerythritol (9%), ethylene glycol (12%),hexamethylenetetraamine (5%) and miscellaneous items (14%).

Oleic acid is made by the saponification of animal, corn, cottonseed and linseed oils and fats, followed by purification or fractionation into the various components of which oleic acid is one. Commercial "oleic" acid or red oil is a byproduct of the production and purification of stearic acid obtained from animal fats. Oleic acid is used in plasticizers (as the ester), in surface active agents (amine derivatives, esters, etc.), and in lubricants.[1433]

Phthalic anhydride is made by several processes which involve the catalytic ($V_2O_5$) catalyst gas phase air oxidation of either napthalene or o-xylene at 300 to 500 C to phthalic acid which then dehydrates to phthalic anhydride (Equations 9,10).[1501]



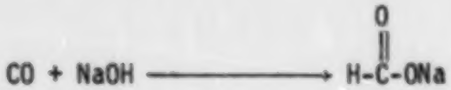
(9)



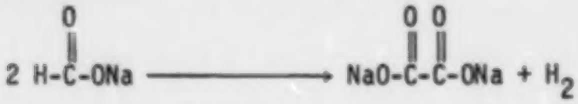
(10)

Phthalic anhydride is used to make diesters such as dioctyl phthalate which are used as plasticizers (48%), in alkyd resins (30%), in unsaturated polyester resins (14%) and in the manufacture of dyes and chemical intermediates (8%).[1506]

Sodium formate is an intermediate in the production of formic acid and sodium oxalate. The reaction of carbon monoxide with sodium hydroxide at 100 to 150 psi produces sodium formate (Equation 11). After the initial reaction, the excess carbon monoxide may be vented and the temperature raised to 375 to 400 C to produce sodium oxalate (Equation 12).



$$CO + NaOH \longrightarrow H\text{-}\overset{\overset{O}{\|}}{C}\text{-}ONa \qquad (11)$$



$$2\ H\text{-}\overset{\overset{O}{\|}}{C}\text{-}ONa \longrightarrow NaO\text{-}\overset{\overset{O}{\|}}{C}\text{-}\overset{\overset{O}{\|}}{C}\text{-}ONa + H_2 \qquad (12)$$

The major use of sodium formate is to make formic acid which is used mainly for textile dyeing and finishing (50%), chemical synthesis (25%) and in the leather industry (15%). Sodium oxalate is used to make oxalic acid which is utilized in metal and equipment cleaning (27%), laundry, textile and leather industries (27%), for chemicals (25%) and other miscellaneous uses (21%).[1506]

## Physical and Chemical Properties

The physical and chemical properties of the compounds discussed in this report are included in the attached worksheets.

## 2. TOXICOLOGY[0766,1433]

Acetyl Chloride, Acetic Anhydride and Acetic Acid. Acetic acid and its derivatives are irritants and corrosive on contact with tissue, particularly the eyes and upper respiratory tract. Systemic effects can be avoided by heeding the warnings of its presence - coughing and a burning sensation in the nose and throat. Ingestion causes a burning pain in the stomach followed by nausea and vomiting. Contact with the skin will cause reddening which may be followed by wrinkling, whitening and peeling. Repeated contact can cause dermatitis. Acetyl chloride will react instantly in the mouth causing corrosive damage and has its own toxic effect due to reaction with the -SH groups of protein molecules.

Phthalic Anhydride and Oleic Acid. These compounds present a very slight danger and the toxic effects are readily reversible.

Formaldehyde solution. Toxic effects are mainly those of irritation. If swallowed, it causes violent vomiting and diarrhea which can lead to collapse and even death. Repeated skin contact can cause dermatitis.

Sodium Formate and Sodium Oxalate. The toxic effects of these compounds resemble those of formic acid and oxalic acid respectively, except that acute local effects are much reduced due to lack of acidity. The presence of dusts or vapor causes irritation of the eyes and upper respiratory tract. Continued contact may cause ulcerations of the respiratory tract and skin lesions characterized by cracking and fissuring of the skin. The effect of ingestion of sodium formate is similar to that of acetic anhydride, but relatively mild compared to sodium oxalate. The systemic effects of sodium oxalate poisoning are mainly due to the removal of calcium from the blood by precipitation of calcium oxalate which clogs the renal tubes causing profound kidney disturbance.

The Threshold Limit Values (TLV) and maximum allowable concentrations that have been established are:

| Substance | TLV<br>ppm | TLV<br>mg/M$^3$ | MAC<br>ppm |
|---|---|---|---|
| Acetic acid | 10 | 25 | |
| Acetic anhydride | 5 | 21 | 12 |
| Acetyl chloride | | | |
| Formaldehyde | 5 | 6 | 5 |
| Oleic acid | | | |
| Phthalic anhydride | 2 | 12 | |
| Sodium formate | 5 | 9[a] | |
| Sodium oxalate | | 1[a] | |

a) as free acid.

## 3. OTHER HAZARDS

Acetyl chloride and acetic anhydride can react violently with water, alcohols, amines and other active hydrogen compounds unless the heat of reaction is adequately dissipated.[1433,1569]

### Handling, Storage and Transportation

With the exception of oleic acid and phthalic anhydride, these materials are all toxic to a certain extent by inhalation and are moderate to extensive skin, mucous membrane and respiratory tract irritants. Thus, these materials should be handled in a well-ventilated area and protective clothing and respirators are recommended where necessary. In cases of accidental contact, all contaminated clothing should be removed instantly and the skin washed thoroughly with soap and water. Showers and eye fountains must be available for serious accidents.

Storage of these materials should be in cool, dry, well-ventillated areas, away from acute fire hazards. Acetyl chloride, with its low boiling point should be protected from excessive heat and against sudden rise in temperature.

These materials are shipped under a variety of U.S.Department of Transportation, Coast Guard and IATA regulations. Most regulations relate to the flammability, corrosiveness and volatility of these compounds.[0766] Information on safe handling and use of these compounds can be found in the Chemical Data Sheets published by the Manufacturing Chemists Association,[2443-2446] standard reference sources,[0766,1433,1492] or manufacturers' Technical Data Sheets.[2447]

## Use/Disposal

The chemicals in this group are used almost exclusively within the chemical process industries as chemical intermediates in the production of plastics, resins, plasticizers, surface agents and organic chemicals. These uses are characterized by a very high degree of utilization due to recycling of the unreacted materials, the main source of waste being scrubbing solutions used to remove trace amounts of reactants.[1506]

Both sodium formate (as the salt and free acid) and, to a much lesser extent, oxalic acid, are used in textile finishing and in leather tanning. Both industries generate large amounts of aqueous wastes with very high chemical and biological oxygen demands, of which only a small part is due to formic and oxalic acids. These wastes have been of some concern for a long time and presently most are treated by conventional activated sludge methods either on site or via contracts with local sewage treatment plants.[1433]

Sodium oxalate and oxalic acid are used extensively for metal and equipment cleaning. In such applications, they are used in small amounts periodically or as necessary at widely scattered sites. Presently, they are discharged directly into the sewer with little or no treatment.

Recommended air and water standards are listed below. The air standard is 0.01 TLV and the water standard os 0.01 TLV by weight in 2 liters of water. No standards have been recommended for compounds for which TLV's have not been established.

| Substance | Limit for Air (Man) ppm | Limit for Air (Man) mg/M$^3$ | Limit for Water (Man) ppm or mg/ℓ | Limit for Water (Fish) ppm or mg/ℓ |
|---|---|---|---|---|
| Acetic Acid | .10 | .25 | 1.25 | 2.5 |
| Acetic Anhydride | .05 | .20 | 1.20[a] | 2.5[a] |
| Acetic Chloride | | | 1.25[a] | 2.5[a] |
| Oleic Acid | | | | |
| Phthalic Anhydride | .02 | .12 | | |
| Formaldehyde | .05 | .06 | .15 | 2.5 |
| Sodium Formate[b] | .05 | .09 | .45 | 470 |
| Sodium Oxalate[b] | | .01 | .05 | 10 |

[a] Decomposes into acetic acid.

[b] As free acid.

## 5. EVALUATION OF WASTE MANAGEMENT PRACTICES

### Option No.1 - Disposal of Acetyl Chloride, Acetic Anhydride and Phthalic Anhydride by Reaction with Water

Small amounts of acetyl chloride, acetic anhydride and phthalic anhydride can be destroyed by reaction with water. Acetyl chloride and acetic anhydride react vigorously with water to produce acetic acid while phthalic acid will react slowly in basic solution to produce a soluble phthalate salt. After conversion to the free acid or acid salt and suitable dilution, they may be treated according to Option No.2 before final discharge.

### Option No.2 - Treatment of Waste Water to Reduce Biological and Chemical Oxygen Demand

Aqueous solutions of the carbonyl compounds treated in this report are ideal candidates for chemical and biological degradation.[1543] These solutions may either be the result of dissolving waste material in water or of a process that produces aqueous waste streams. Depending on the quality and quantity of effluent generated at a given site, treatment can be carried out on site and/or by municipal waste treatment systems. Final discharge should meet water quality standards.

### Option No.3 - Incineration

With the exception of sodium formate and sodium oxalate, unusable bulk materials in this group can be disposed of by incineration. Conversion of sodium formate and oxalate into formic and oxalic acids would allow incineration of these materials also.

### Option No.4 - Process Modification as a Method of Waste Reduction

The growing pressure on the chemical process industries to control wastes from their manufacturing sites has caused a reexamination of operating conditions and potential recovery value of wastes. In fact, process modifications in the production of formaldehyde and acetic acid have substantially reduced the amount of wastes that are produced.[0314] Continued application of this approach is an excellent method of "waste treatment."

## 6. APPLICABILITY TO NATIONAL DISPOSAL SITES

The wastes generated by the industries that produce and use these materials can be handled and treated locally by incineration and conventional water treatment. Incineration should be available at the National Disposal Site where the industry generating the waste has a special problem or can not handle a specific problem safely.

## 7. REFERENCES

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2444 Acetic anhydride chemical safety data sheet SD-15. Washington, Manufacturing Chemists Association, 1967. 16 p.

2445 Acetic acid chemical safety data sheet SD-41. Washington, Manufacturing Chemists Association, 1951. 15 p.

2446 Phthalic anhydride chemical safety data sheet SD-61. Washington, Manufacturing Chemists Association, 1956. 16 p.

2447 Technical data sheet for organic acids and anhydrides. New York, Union Carbide Chemicals Company, 1960. 48 p.

2

## HAZARDOUS WASTES PROPERTIES
## WORKSHEET

H. M. Name Acetic acid

IUC Name methanoic acid

Common Names vinegar acid, methane carboxylic acid

Structural Formula

$CH_3$-$CO_2H$

Molecular Wt. 60.05 Melting Pt. 16.7 C(1) Boiling Pt. 118 C(1)

Density (Condensed) 1.049 @ 25/25 C(1) Density (gas) 2.07(2) @

Vapor Pressure (recommended 55 C and 20 C)

11.4 mm @ 20 C(2) @ @

Flash Point 109 F(C.C.)(1) Autoignition Temp. 800 F(2)

Flammability Limits in Air (wt %) Lower Upper

Explosive Limits in Air (wt. %) Lower 5.4%(2) Upper 16.0%(2) at 212 F

Solubility

Cold Water miscible Hot Water miscible Ethanol miscible

Others: miscible glycerol, carbon tetrachloride; very slightly carbon disulfide

Acid, Base Properties $K_a = 1.8 \times 10^{-5}$

Highly Reactive with oxidizing agents such as nitric acid, chromic acid or anhydride, hydrogen peroxide, perchloric acid, sodium peroxide and permanganates(3)

Compatible with

Shipped in

IATA ~~ICC~~ Classification corrosive liquid, white label Coast Guard Classification combustible liquid

Comments

References (1) 1492
(2) 0766
(3) 1569

## HAZARDOUS WASTES PROPERTIES
## WORKSHEET

3

H. M. Name Acetic anhydride

IUC Name ethnoic anhydride

Common Names acetyl oxide, acetic oxide

Structural Formula

$(CH_3\text{-}CO)_2O$

Molecular Wt. 102.09 Melting Pt. -73.1 C(1) Boiling Pt. 140 C(1)

Density (Condensed) 1.082 @ 20/4 C(1) Density (gas) 3.52(1) @

Vapor Pressure (recommended 55 C and 20 C)

10 mm @ 36 C(1) @ @

Flash Point 129 F(C.C.)(1) Autoignition Temp. 734 F(1)

Flammability Limits in Air (wt %) Lower Upper

Explosive Limits in Air (wt. %) Lower 2.7%(1) Upper 10.1%(1)

Solubility

Cold Water soluble decomposition(2) Hot Water Ethanol soluble decomposition(2)

Others: soluble chloroform(2)

Acid, Base Properties

Highly Reactive with oxidizing agents such as chromic acid, chromic anhydride, nitric acid, perchloric acid, peroxides, permanganates.(3)

Compatible with

Shipped in

IATA Classification corrosive liquid, white label Coast Guard Classification combustible liquid

Comments

References (1) 0766
(2) 1492
(3) 1569

9

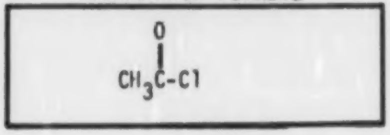
## HAZARDOUS WASTES PROPERTIES WORKSHEET

H. M. Name Acetyl chloride

IUC Name etahnoyl chloride

Common Names

Structural Formula



$CH_3\overset{\overset{O}{|}}{C}-Cl$

Molecular Wt. 78.50  Melting Pt. -112 C(1)  Boiling Pt. 51-52 C(1)

Density (Condensed) 1.1051 @ 20/4 C(1)  Density (gas) 2.70(1) @

Vapor Pressure (recommended 55 C and 20 C)

@  @  @

Flash Point 40 F(C.C.)(1)  Autoignition Temp. 734 F(1)

Flammability Limits in Air (wt %)  Lower  Upper

Explosive Limits in Air (wt. %)  Lower  Upper

Solubility

Cold Water decomposed(2)  Hot Water decomposed(2)  Ethanol decomposed(2)

Others: miscible benzene, chloroform, ether, glacial acitic acid, petroleum ether.(2)

Acid, Base Properties

Highly Reactive with water and alcohols to form acetic acid and acetates.(2) Reaction can be violent.(3)

Compatible with

Shipped in

IATA: Corrosive liquid, white label(1)

ICC Classification corrosive liquid, white label(1)  Coast Guard Classification white label(1)

Comments

References (1) 0766
(2) 1492
(3) 1569

## HAZARDOUS WASTES PROPERTIES WORKSHEET

201

H. M. Name Formaldehyde, gas

IUC Name methanol

Common Names oxomethane, oxymethylene, methylene oxide, formic aldehyde, methyl aldehyde.

Structural Formula

$CH_2O$

Molecular Wt. 30.03 Melting Pt. -92 C(1) Boiling Pt. -19.5 C(1)

Density (Condensed) 0.815 @ -20/4 C(1) Density (gas) 1.067(1) @

Vapor Pressure (recommended 55 C and 20 C)

@ @ @

Flash Point Autoignition Temp. 572 F(1)

Flammability Limits in Air (wt %) Lower Upper

Explosive Limits in Air (wt. %) Lower Upper

Solubility

Cold Water 55 %(2) Hot Water Ethanol soluble(2)

Others:

Acid, Base Properties

Highly Reactive with

Compatible with

Shipped in

ICC Classification Coast Guard Classification

Comments polymerizes very easily.

References (1) 0766
(2) 1492

201

## HAZARDOUS WASTES PROPERTIES WORKSHEET

H. M. Name Formaldehyde, aqueous solution*

IUC Name methanol

Common Names see formaldehyde, gas

Structural Formula

$CH_2O$

Molecular Wt. 30.03 Melting Pt. ______ Boiling Pt. -3 F(2)

Density (Condensed) 1.08 @ 25/25 C(1) Density (gas) ______ @ ______

Vapor Pressure (recommendeo 55 C and 20 C)

______ @ ______ ______ @ 806 F(2) ______ @ ______

Flash Point ______ Autoignition Temp. ______

185 F (37% methanol free); 122 F (15%, methanol free)(2)

Flammability Limits in Air (wt %) Lower ______ Upper ______

Explosive Limits in Air (wt. %) Lower 7.0% Upper 73.0%

Solubility

Cold Water miscible(1) Hot Water ______ Ethanol miscible(1)

Others: miscible, acetone(1)

Acid, Base Properties Acid, pH 2.8 - 4.0(1)

Highly Reactive As a reducing agent especially in the presence of base.

Compatible with ______

Shipped in ______

ICC Classification ______ Coast Guard Classification ______

Comments Shipped as 37% to 50% solution. The 37 wt.% solution with 10-15% methanol as a stabilizer is the most common.(1)

Polymerizes to form paraformaldehyde (trioxymethylene).

References (1) 1492
(2) 0766

*Data for 37% solution.

## HAZARDOUS WASTES PROPERTIES WORKSHEET

314

H. M. Name Oleic acid

IUC Name *cis*-9-octadecenoic acid

Common Names

Structural Formula

$C_{18}H_{34}O_2$

Molecular Wt. 282.45 Melting Pt. 14 C(2) Decomposition Pt. 80-100 C(1)

Density (Condensed) 0.895 @25/25 C Density (gas) @

Vapor Pressure (recommended 55 C and 20 C)

1 mm @ 176.5 C(2) @ @

Flash Point 372 F(2). Autoignition Temp. 685 F(2)

Flammability Limits in Air (wt %) Lower Upper

Explosive Limits in Air (wt. %) Lower Upper

Solubility

Cold Water insoluble(1) Hot Water Ethanol soluble(1)

Others: soluble benzene, chloroform, ether, oils(1)

Acid, Base Properties

Highly Reactive with

Compatible with

Shipped in

ICC Classification Coast Guard Classification

Comments

References (1) 1492
(2) 0766

337

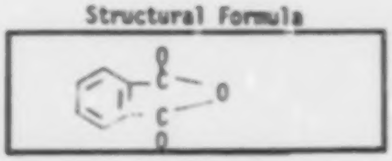
# HAZARDOUS WASTES PROPERTIES WORKSHEET

H. M. Name Phthalic anhydride

IUC Name

Common Names phthalandione

Structural Formula



Molecular Wt. 148.11 Melting Pt. 131.2 C(1) Boiling Pt. 248.5 C(1)

Density (Condensed) 1.527 @ 4 C(1) Density (gas) 5.10(1) @

Vapor Pressure (recommended 55 C and 20 C)

1 mm @ 96.5 C(1) @ @

Flash Point 305 C(C.C.)(1) Autoignition Temp. 1083 F(1)

Flammability Limits in Air (wt %) Lower Upper

Explosive Limits in Air (wt. %) Lower 1.7% Upper 10.4%(1)

Solubility

Cold Water 1% (Decomp.)(2) Hot Water soluble (decomp)(2) Ethanol soluble(2)

Others: 1% carbon disulfide, sparingly in ether

Acid, Base Properties neutral

Highly Reactive with water and alcohol to form free acid or esters and half esters.

Compatible with

Shipped in
MCA warning label(1)

ICC Classification Coast Guard Classification

Comments A common air contaminant.

References (1) 0766
(2) 1492

390

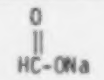
HAZARDOUS WASTES PROPERTIES
WORKSHEET

H. M. Name Sodium formate

IUC Name

Common Names

Structural Formula



$HC(=O)-ONa$

Molecular Wt. 68.02 Melting Pt. 253 C(1) Boiling Pt.

Density (Condensed) 1.92 @ 20 C(1) Density (gas) @

Vapor Pressure (recommended 55 C and 20 C)

@ @ @

Flash Point Autoignition Temp.

Flammability Limits in Air (wt %) Lower Upper

Explosive Limits in Air (wt. %) Lower Upper

Slight fire hazard.

Solubility

Cold Water very soluble(2) Hot Water very soluble(2) Ethanol slightly(2)

Others: soluble in glycerol

Acid, Base Properties neutral, pH 7 in aq.solution. Used as a buffer.(2)

Highly Reactive with

Compatible with

Shipped in

ICC Classification Coast Guard Classification

Comments

References (1) 0766
(2) 1492

398

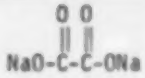
## HAZARDOUS WASTES PROPERTIES
## WORKSHEET

H. M. Name Sodium oxalate

IUC Name

Common Names

Structural Formula



$NaO-\overset{\overset{O}{\|}}{C}-\overset{\overset{O}{\|}}{C}-ONa$

Molecular Wt. 134.01 Melting Pt. Boiling Pt.

Density (Condensed) 2.34(2) @ Density (gas) @

Vapor Pressure (recommended 55 C and 20 C)

@ @ @

Flash Point Autoignition Temp.

Flammability Limits in Air (wt %) Lower Upper

Explosive Limits in Air (wt. %) Lower Upper

Slight fire hazard(2)

Solubility

Cold Water 4%(1) Hot Water 7%(1) Ethanol insoluble(1)

Others:

Acid, Base Properties neutral aq. solution

Highly Reactive with

Compatible with

Shipped in

ICC Classification Coast Guard Classification

Comments

References (1) 1492
(2) 0766

# PROFILE REPORT

## Acetone Cyanohydrin (5), Acetonitrile (6), Acrylonitrile (11), Cyanoacetic Acid (130), Ethylene Cyanohydrin (183) and Toluene Diisocyanate (511)

## 1. GENERAL

### Introduction[1433]

The nitriles and isocyanate discussed in this report have been previously selected as probable candidates for industrial disposal because of their well-defined handling and treatment methods.

The nitriles are organic compounds containing a cyano radical, -CN, as the characteristic functional group. Toluene diisocyanate is distinguished by the presence of two isocyanate (-NCO) groups attached to the aromatic nucleus.

These materials have been grouped for discussion in this report because of their chemical and physical similarities and amenability to similar disposal procedures.

### Manufacture[1433]

Acetone Cyanohydrin. This hydroxynitrile is produced by a continuous process involving the reaction of acetone with hydrogen cyanide at 10 to 15 C, at a pH of 6.5 to 7.5. The reaction is a general method for the preparation of hydroxynitriles from aldehydes or ketones.

Acetonitrile. Acetonitrile is prepared by vapor phase ammonolysis of glacial acetic acid. The acid is vaporized, mixed with anhydrous ammonia, and the stream directed through a bed of silica gel or some other dehydration catalyst. The bed temperature may range from 150 to 500 C in this continuous process. The effluent gases contain acetonitrile, ammonia and water and the product is recovered in 85 to 95 percent yields by azeotropic distillation.

Acrylonitrile. Acrylonitrile is currently produced from:(1) ethylene cyanohydrin; (2) acetylene and hydrogen cyanide; and (3) propylene and ammonia. In addition, several other possibly useful processes are described in the patent literature. The reaction of acetylene with hydrogen cyanide is utilized in the production of about two-thirds of the acrylonitrile produced in the United States.

Cyanoacetic Acid. The reaction of sodium cyanide with chloroacetic acid is employed in the commercial production of cyanoacetic acid. This method provides the acid in 90 percent yield.

Ethylene Cyanohydrin. Ethylene cyanohydrin is prepared by heating ethylene oxide and hydrogen cyanide together under controlled conditions.

Toluene Diisocyanate. Commercial manufacturing processes for aromatic isocyanates have the following general route: (1) a solution of an aromatic amine in an aromatic solvent such as xylene, monochlorobenzene, or *o*-dichlorobenzene is mixed with a solution of phosgene in the same solvent at a temperature below 60 C; (2) the resulting slurry is then digested in one to three stages for several hours at progressively increasing temperatures up to 200 C with the introduction of additional phosgene; and (3) the final solution of reaction products is fractionated to recover hydrogen chloride, unreacted phosgene and solvent for recycling, a distillation residue which is incineration, and the desired isocyanate.

## Uses

Acetone Cyanohydrin.[1433] The major use of acetone cyanohydrin is in the preparation of α-methacrylic acid and its esters, which are employed as monomers in the plastics industry. It is also used to prepare ethyl α-hydroxyisobutyrate, a pharmaceutical intermediate.

Acetonitrile.[1492] This nitrile is used as a starting material in the organic synthesis of many chemicals. It also is used to remove tars, phenol, and coloring matter from petroleum hydrocarbons as well as to extract fatty acids from animal and vegetable oils. It is a good non-aqueous solvent for inorganic salts and therefore is commonly used as a medium for analytical titrations.

Acrylonitrile.[1433] A wide variety of uses have been developed for acrylonitrile, particularly in synthetic fibers, plastics, modified natural fibers, polyelectrolytes and as a chemical intermediate.

Cyanoacetic Acid.[1492] Cyanoacetic acid is used in the synthesis of many intermediates and in the manufacture of barbital.

Ethylene Cyanohydrin.[1433] This material is manufactured on a large scale as an intermediate for acrylonitrile, acrylic acid, and acrylic acid ester.

Toluene Diisocyanate. Toluene diisocyanate is used extensively in the manufacture of polyurethan foams, elastomers and coatings for wire.

### Physical and Chemical Properties

The physical and chemical properties of these materials are included in the attached worksheets.

## 2. TOXICOLOGY

### Nitriles

The toxicity of nitriles ranges from high to moderate but they are only moderately hazardous as compared to hydrocyanic acid or to the isomeric organic isonitriles. Toxic quantities of nitriles may enter the body by ingestion, inhalation, and contact with the skin.[1433] Early symptoms of exposure to toxic concentrations of acrylonitrile include irritation of the eyes, nausea, and headache. The appearance of such symptoms necessitates immediate termination of the exposure.[2294] Nitriles act like cyanides with respect to human toxicity,[0766,1492] physiologically inhibiting tissue oxidation and causing death through asphyxia. The nitriles are, however, generally considered somewhat less toxic than hydrocyanic acid and other volatile inorganic cyanides as cyanogen because of their lower volatility.[0766]

Toluene diisocyanate can be hazardous in either its liquid or vapor form. On contact with the skin or eyes it produces irritation and if not removed immediately may cause burns. Inhalation of the vapors may be injurious to the lungs. The vapor is capable of producing difficult and labored breathing. Some individuals may develop a hypersensitivity to the vapors, and may then respond to very low concentrations.

## 3. OTHER HAZARDS

Caution must be observed when handling acetone cyanohydrin. This material readily decomposes to hydrogen cyanide and acetone. It should be kept in a slightly acidic environment,[0766] but strongly acid conditions should be avoided.[1569]

Acetonitrile will react with water, steam or acids to produce toxic and flammable vapors. It also can react vigorously with oxidizing materials.[0766]

Acrylonitrile ignites very readily. Its vapors, diffused in air over a considerable range of concentration are highly explosive. This material polymerizes violently in the presence of strong bases. Pure acrylonitrile is subject to self-polymerization with rapid pressure development in closed containers.[2294] Concentrated sulfuric acid mixtures must be kept well chilled to prevent a vigorous exothermic reaction occurring.[1569]

Ethylene cyanohydrin will react with water or steam to produce toxic and flammable vapors. It can also react vigorously with oxidizing materials.[0766]

Care should be taken to prevent toluene diisocyanate from coming into contact with basic compounds which might cause uncontrollable polymerization to take place. Large amounts of acidic materials may also cause rapid polymerization.[2295] Exposure of toluene diisocyanate to moisture leads to the formation of carbon dioxide and development of pressure in closed containers.[1437]

All of the subject materials are considered dangerous when heated to decomposition due to the emission of highly toxic fumes.[0766]

## 4. DEFINITION OF ADEQUATE WASTE MANAGEMENT

### Handling, Storage, Transportation

All precautions must be taken to guard against health and fire hazards wherever these materials are handled. If leaks or spills occur, only properly protected personnel should remain in the area. Leaking containers should be removed to the outdoors or to an isolated, well-ventilated area, and the contents transferred to other suitable containers.

The section on "Other Hazards" should be consulted in determining which of these materials may not be exposed to water during clean-up operations. Carbon dioxide, dry chemical or carbon tetrachloride are suitable materials for fighting fires.[0766]

A list of hazardous materials with packing and shipping instructions is found in the Code of Federal Regulations, Title 49, parts 100 to 199 (accession No. 278). Instructions are also included for articles whose proper shipping name is not shown in the commodity list and which must be classified as dangerous.

### Disposal/Reuse

Contaminated or degraded materials found to be unusable in a recycling process must be disposed of in a safe manner, defined in terms of the recommended maximum concentrations released to the environment. These recommended maximum concentrations are as follows:

| Contaminant in Air | Provisional Limits | Basis for Recommendation |
|---|---|---|
| Acetone cyanohydrin | | |
| Acetonitrile | 0.4 ppm (0.7 mg/$M^3$)/24 hrs | 0.01 TLV |
| Acrylonitrile | 0.2 ppm (0.45 mg/$M^3$/24 hrs | 0.01 TLV |
| Cyanoacetic acid | | |
| Ethylene cyanohydrin | | |
| Toluene diisocyanate | | |

| Contaminant in Water | Provisional Limits |
|---|---|
| Acetone cyanohydrin | |
| Acetonitrile | 3.5 mg/l/24 hrs |
| Acrylonitrile | 1.99 mg/l/24 hrs |
| Cyanoacetic acid | |
| Ethylene cyanohydrin | |
| Toluene diisocyanate | |

## 5. EVALUATION OF CURRENT AND NEAR FUTURE DISPOSAL PROCESSES

### Option 1. Recycling of Concentrated Waste

It would be advisable in all cases to first contact the manufactuers to determine if the material can be recycled. The applicability of this option depends on the type and extent of contamination or degradation the material has suffered.

### Option 2. Incineration of Concentrated and Dilute Organic Waste

In the event it becomes necessary to dispose of a significant quantity of organic waste and purification/recycling is impractical, incineration of the materials is the recommended method of disposal. The material must be incinerated under controlled conditions whereby oxides of nitrogen are removed from the effluent gas by scrubber or a thermal device.[1435]

## Option 3. Biological Treatment of Dilute Aqueous Waste

Nitriles are generally considered to be biodegradable.[0314] Some compounds can be degraded biologically only after extended periods of seed acclimation. The amenability of a particular compound to biological degradation is highly dependent on such environmental and growth factors as the nutrient requirements necessary for biological growth, and proper pH and temperature conditions for the microorganism. Conditions for the biological treatment of these individual compounds must be tailored to the particular waste stream in which they appear.

## Option 4. Activated Carbon Treatment of Dilute Aqueous Waste[0314]

Nitriles can be removed from waste water by treatment with activated carbon when they are present in low concentrations. This option is in essence a final "polishing" step to be used in conjunction with Option 3 to complete removal of resistant compounds from the stream before it is returned to the environment.

## 6. APPLICABILITY TO NATIONAL DISPOSAL SITES

Most of the wastes generated by the industries that produce and use these materials can best be handled and treated at the site of the generation by methods discussed in Section 5. Since adequate methods are available for disposal of these materials and they can be implemented by the manufacturers and users, they are not judged to be specific candidate constituents for National Disposal Sites, although that may well appear in mixed waste streams containing candidate constituents.

# 7. REFERENCES

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## HAZARDOUS WASTES PROPERTIES
## WORKSHEET

5

H. M. Name Acetone Cyanhydrin

IUC Name 2-hydroxy-2-methylpropane nitrile(1)

Structural Formula

$(CH_3)_2C(UH)CN$

Common Names Acetone Cyanohydrin(2)
α-hydroxy isobutyronitrile(1)(2) 2-methyllactonitrile(2)
2-hydroxy-2-methyl propanoic acid nitrile(3)

Molecular Wt. 85.10(4) Melting Pt. -20 C(4) Boiling Pt. 82 C @ 23 mm(4)

Density (Condensed) 0.932 @ 19 C(4) Density (gas) 2.93 @ air = 1

Vapor Pressure (recommended 55 C and 20 C)

@ @ @

Flash Point Autoignition Temp. 1270 F(4)

Flammability Limits in Air (wt %) Lower Upper

Explosive Limits in Air (wt. %) Lower Upper

Solubility

Cold Water Soluble(2) Hot Water Soluble(2) Ethanol Soluble(2)

Others: Very soluble in ether(3) Insoluble in Ret. Ether(3)
Very soluble in organic solvents(3)

Acid, Base Properties

Highly Reactive with

Compatible with

Shipped in

ICC Classification Poison B(4) Coast Guard Classification Poison B(4)

Comments

References (1) 1433 (4) 0766
(2) 1492
(3) 1570

# HAZARDOUS WASTES PROPERTIES
# WORKSHEET

6

H. M. Name Acetonitrile

IUC Name Ethanenitrile(1)

Common Names Cyanomethane(1) Methyl Cyanide(1)

Structural Formula

$CH_3CN$

MLD(2) s.c. rabbits. 130 mg/Kg

$LD_{50}$(2) oral rats: 3.8 g/Kg

Molecular Wt. 41.05(1)    Melting Pt. -45.72 C(1)    Boiling Pt. 80.06 C(1)

Density (Condensed) 0.7856(1) @ 20    Density (gas) 1.42(4) @

0.78745 @ 15/4    $n_D^{20}$ 1.3441(1)

Vapor Pressure (recommended 55 C and 20 C)

8.7 mm Hg @ 24    310 mm Hg @ 55    100 mm Hg @ 27(4)

Flash Point 12.8(2)    Autoignition Temp.

Flammability Limits in Air (wt %)    Lower    Upper

Explosive Limits in Air (wt. %)    Lower    Upper

Combustible w/non toxic residue (Booz Allen)

Solubility

Cold Water ∞(1)    Hot Water    Ethanol ∞(1)

Others: ∞ soluble in ether(1), methanol(2) methyl acetate(2) ethylacetate(2) acetone(2) acetamide(2) Sol(2) Chloroform(2) $CCl_4$(2) ethylene chloride(2)

Acid, Base Properties

Highly Reactive with Highly toxic(4) Can react vigorously with oxidizing materials(4) Will react with water, steam, or acids to produce toxic and flammable vapors(4)

Compatible with

Shipped in

ICC Classification    Coast Guard Classification

Comments Max. practical working level: 20 ppm(2) Source(3): Baird Chemical Industries, Inc.; Conray Products Co.; Eastman Chemical Products, Inc; Lonza Ltd.; Vistron Corp.

References (1) 1570
(2) 1492
(3) 0571
(4) 0766

## HAZARDOUS WASTES PROPERTIES
## WORKSHEET

11

H. M. Name Acrylonitrile

IUC Name

Common Names Propenenitrile(1) Vinylcyanide(1)
Cyanoethylene(2) Fumagrain(2) Ventox(2) $LD_{50}$(2)
oral rats: 93 mg/Kg

Structural Formula

$CH_2$:CHCN

Molecular Wt. 53.06(1)     Melting Pt. -82 C(1)     Boiling Pt. 77.5 - 9 C(1)

Density (Condensed) 0.8060 @ 20/4     Density (gas) 1.83(4) @

MAC 20 ppm(4)

Vapor Pressure (recommended 55 C and 20 C)

100 mm Hg @ 22.8 C(4)     330 mm @ 55 C     @

Flash Point 32 F (45 F)     Autoignition Temp. 898 F(4)

Flammability Limits in Air (wt %)     Lower     Upper

Explosive mixtures with air     Lower 3.05%     Upper 17.0%

**Solubility**

Cold Water Soluble     Hot Water     Ethanol ∞

Others: ∞ soluble in ether

Acid, Base Properties

Highly Reactive with Polymerizes in the presence of peroxides(2) Highly flammable, highly toxic, highly explosive (Booz Allen)

Compatible with

Shipped in ICC 17E Iron Drum

ICC Classification Flammable liquid     Coast Guard Classification Inflammable liquid

Comments Sources(3): American Cyanamid Co. Conray Products Co.; E. I. duPont de Nemours & Co; B. F. Goodrich Chemical Co.; International Chemical Corp.; Monsanto Co.; Union Carbide Corp.; Vistron Corp.

References (1) 1570
(2) 1492
(3) 1571
(4) 0766

HAZARDOUS WASTES PROPERTIES
WORKSHEET

130

H. M. Name Cyanoacetic Acid

IUC Name

Common Names Malonic Mononitrile

Structural Formula

$NCCH_2COOH$

Molecular Wt. 85.06(1)

Melting Pt. 66 (1)

Boiling Pt. 160 d; $b_{15}$ 108

Density (Condensed) ____ @ ____ ____

Density (gas) ____ @ ____ ____

Vapor Pressure (recommended 55 C and 20 C)

____ @ ____ ____ @ ____ ____ @ ____

Flash Point

Autoignition Temp.

Flammability Limits in Air (wt %) Lower ____ Upper ____

Explosive Limits in Air (wt. %) Lower ____ Upper ____

Solubility

Cold Water Soluble

Hot Water

Ethanol Soluble

Others: Soluble in ether, slightly soluble in benzene, chloroform.

Acid, Base Properties $pK_a^{25}$ 2.44(4)

Highly Reactive with Decomposes at 160 into $CO_2$ and acetonitrile. Highly toxic(3)

Compatible with

Shipped in

ICC Classification

Coast Guard Classification

Comments Sources(2). Kay-Fries Chemicals Inc.

References (1) 1492
(2) 1571
(3) 0766
(4) 1655

183

## HAZARDOUS WASTES PROPERTIES
## WORKSHEET

H. M. Name Ethylene cyanohydrin

IUC Name 3-hydroxy propane nitrile

Common Names Ethylene cyanohydrin(1)
Hydracrylonitrile(1)

Structural Formula

$HOCH_2CH_2CN$

Molecular Wt. 71.08(1) Melting Pt. -46 C(2) Boiling Pt. 227-228 C(2)

Density (Condensed) 2.45(3) @ ____ ____ Density (gas) 1.0404 @ 25 C(3)

Vapor Pressure (recommended 55 C and 20 C)

0.08 @ 25 C(3) ____ @ ____ ____ @ ____

Flash Point <80 F(3) Autoignition Temp. ____

Flammability Limits in Air (wt %) Lower ____ Upper ____

Explosive Limits in Air (wt. %) Lower ____ Upper ____

Solubility

Cold Water Infinitely soluble(1) Hot Water ____ Ethanol Infinitely soluble

Others: Sparcely soluble in ether(1) Insoluble in $CS_2$(1)

Acid, Base Properties ____

Highly Reactive with ____

Compatible with ____

Shipped in ____

ICC Classification ____ Coast Guard Classification ____

Comments ____

References (1) 1570
(2) 1433
(3) 0766

## HAZARDOUS WASTES PROPERTIES
## WORKSHEET

511

H. M. Name Toluene diisocyanate

IUC Name ____________

Structural Formula

$CH_3C_6H_3(NCO)_2$

Common Names Toluene diisocyanate(1)
Tolylene diisocyanate, TDI

Molecular Wt. 174.15(2)    Freezing Pt. 21.5 C    Boiling Pt. 251 C

Density (Condensed) 1.22 @ 25/15.5 C(1) Density (gas) 6.0 (Air = 1) @ ______ ______

Vapor Pressure (recommended 55 C and 20 C)

0.01 m @ 25 C    ______ @ ______    ______ @ ______

Flash Point 132 C(1) Ctag open cup    Autoignition Temp. ____

Flammability Limits in Air (wt %)    Lower ________    Upper ________

Explosive Limits in Air (wt. %)    Lower ________    Upper ________

Solubility

Cold Water ________    Hot Water ________    Ethanol ________

Others: ________

Acid, Base Properties Relatively noncorrosive at normal temperatures(1)

Highly Reactive with water with evolution of carbon dioxide(1)

Compatible with ________

Shipped in Drums, tank trucks or tank cars.

ICC Classification ________    Coast Guard Classification ________

Comments Sources(3): Amplex Chem. Co.; BASF Wyandotte Corp.; Conray Products; E. I. duPont de Nemours & Co. Inc (see Ref.)

References (1) 2295
(2) 1492
(3) 1571

# PROFILE REPORT

## ALIPHATIC HYDROCARBONS

Acetylene (7), Butadiene (68), Butane (69, 1-Butene (71), Butylene (76), Cyclohexane (131), Dicyclopentadiene (148), Disobutylene (156), Ethane (493), Ethylene (181), n-Heptane (207), 1-Heptene (208), Hexane (211), Isopentane (225), Isoprene (227), Naphtha (crude)(284), n-Pentane (323), Propane (354), Tetrapropylene (429), Tripropane (Norene)(446), Turpentine (447), Propylene (360).

## AROMATIC HYDROCARBONS

Benzene (54), Creosote (coal tar)(123), Cumene (127), Dodecylbenzene (169), Ethylbenzene (179), Naphthalene (285), Styrene (412), Toluene (434), Xylene (451), Anthracene (466).

## 1. GENERAL

### Introduction

The hydrocarbons treated in this report have all been selected as probable candidates for municipal disposal. These materials are similar in that most are commodity chemicals with relatively low toxicity, well-defined and safe methods of industrial handling and common methods of disposal. The aliphatic and aromatic hydrocarbons are, therefore, discussed as a class in this report.

### Manufacture

The compounds treated in this report, with the exception of those discussed below, are all petroleum-based materials. The saturated hydrocarbons, naphtha, and small amounts of benzene and unsaturated aliphatics are isolated directly from petroleum by distillation. The remainder are classified as petrochemicals and are manufactured at sites within or in close proximity to petroleum refineries.[1655]

The alkenes such as butylene, styrene, propylene, etc., are usually made from the corresponding saturated material by dehydration at high temperature over chromia-alumina catalysts. The use of hexanes or higher hydrocarbons results in the production of benzene, toluene, the xylenes, etc.[2480]

In the last 10 to 20 years, substantial advances in the area of catalytic cracking and refining of petroleum fractions has allowed the production of high volume items such as ethylene, benzene and toluene from a wide variety of materials.[1433,2480]

Dimers, trimers and tetramers are made by selective polymerization of such alkenes as propylene, butylene or cyclopentene. A wide range of catalysts and reaction conditions are employed to produce the required product.[2480]

Naphthalene, creosote and the anthracene are produced from coal tar. Turpentine is made from the destructive distillation of the southern pine, *pinus palustris*.[1492]

## Uses[1433,1492,1655]

The saturated aliphatic and aromatic hydrocarbons as well as turpentine are used in wide variety of applications as fuels, solvents, reaction media and in hundreds of formulations of industrial and consumer items. The alkenes and alkene dimers and trimers are used either to produce polymers directly or to make other monomers.

Creosote is used to protect wood from insects, anthracene is used in the production of dyestuffs and naphthalene in the production of phthalic and anthranilic acids, dyestuffs, resins and in the manufacture of hydronaphthalenes.

More detailed descriptions of the various uses of the aliphatic and aromatic hydrocarbons can be found in standard reference sources.

## Physical and Chemical Properties

The physical and chemical properties of the compounds discussed in this report are included in the attached worksheets.

## 2. TOXICOLOGY

## Aliphatic Hydrocarbons[0766,1492]

The aliphatic hydrocarbons are classified as simple asphyxiant gases having no specific toxic effect, but acting by excluding oxygen from the lungs. Since a 33 percent concentration is necessary before appreciable symptoms develop, they become severe fire and explosion hazards long before danger from lack of oxygen develops. Hydrocarbons with boiling points below room temperature can cause frostbite when spilled on the skin by evaporative cooling. Repeated contact with the skin can cause irritation by removal of the skin oils. Turpentine, a natural product, is a mild allergen and can cause serious kidney irritation.[1492]

## Aromatic Hydrocarbons

The toxicity of the mononuclear aromatic hydrocarbons decreases with increasing alkyl substitution in the ring. Thus benzene is more toxic than toluene, which in turn is more toxic than xylene. Poisoning can occur by inhalation, ingestion or skin absorption.

Locally, these compounds have a relatively strong, irritating effect producing erythema, burning, and in severe cases edema. Exposure to high vapor concentration is similar to other anaesthetic gases.

Chronic exposure is dangerous due to its toxic action on the blood-forming tissue. There are no specific set of blood symptoms in chronic poisoning and individual susceptibility varies widely.

Naphthalene is relatively non-toxic, but poisoning will occur by ingestion of large doses, inhalation or skin absorption causing nausea, vomiting, headache, hemalytic anemia, hepatic necrosis, convulsions, and coma. Anthracene is non-toxic, but it is thought that industrial material is carcinogenic because of impurities.

The Threshold Limit Values (TLV) and Maximum Allowable Concentrations (MAC) that have been established are:

| 1. Aliphatic Hydrocarbons: | TLV ppm | TLV $mg/M^3$ | MAC ppm |
|---|---|---|---|
| Acetylene | | | |
| Butadiene | 1000 | 2200 | |
| Butane | 500 | 1200 | |
| 1-Butene | | | |
| Butylene | | | |
| Cyclohexane | 300 | 1050 | 400 |
| Dicyclopentadiene | | | |
| Diisobutylene | | | |
| Ethane | | | |
| Ethylene | | | |
| n-Heptane | | | |
| 1-Heptene | 500 | 2000 | 500 |
| Hexane | 500 | 1800 | 500 |
| Isopentane | | | |

| Aliphatic Hydrocarbons (cont'd) | TLV<br>ppm | TLV<br>mg/M$^3$ | MAC<br>ppm |
|---|---|---|---|
| Isoprene | | | |
| Naphtha | | | |
| Pentane | 500 | 1500 | 1000 |
| Propane | | | |
| Propylene | | | |
| Tetrapropylene | | | |
| Tripropylene | | | |
| Turpentine | 100 | 560 | 100 |
| 2. Aromatic Hydrocarbons | | | |
| Anthracene | | | |
| Benzene | 25 | 80 | 25 |
| Creosote | | | |
| Cumene | 50 | 245 | 100 |
| Dodecylbenzene | | | |
| Ethylbenzene | 100 | 435 | 100 |
| Naphthalene | 10 | 50 | 10 |
| Styrene | 100 | 420 | 100 |
| Toluene | 100 | 375 | 200 |
| Xylene | 100 | 435 | 200 |

## 3. OTHER HAZARDS

No hazards other than flammability are present during the handling and use of these compounds with the exception of acetylene. Dry salts of acetylene are explosive and very prone to spontaneous detonation.[1569,1655]

## 4. DEFINITION OF WASTE MANAGEMENT PRACTICES

### Handling, Storage and Transportation[0766,1433]

Most of the chemicals in this group are rated as hazardous flammable chemicals because they have flash points below 100 C. In addition, many form explosive mixtures with air at concentrations as low as 1 percent. The danger is further complicated by the fact that very pure material has very little odor.

Care must be exercised in handling, storage and transportation to prevent container leakage. Whenever possible these materials should be kept in cool, well-ventilated areas, away from acute fire hazards. Industrial areas where these hydrocarbons are used, should be equipped with spark-proof electrical apparatus. Materials with low boiling points should be protected from excessive heat and against sudden rise in temperature.

These materials are shipped under a variety of U.S. Department of Transportation, Coast Guard, and IATA regulations. Most regulations relate to the flammability and volatility of these compounds. Information on safe handling and use of these compounds can be found in the Chemical Data Sheets published by the Manufacturing Chemists Association, standard reference sources, or manufacturers' Technical Data Sheets.

## Disposal/Reuse

Petrochemical plants that use the hydrocarbons listed in this report recycle any unused or unreacted material. Hydrocarbons that are used as reaction media or solvents in commercial processes are also recycled indefinitely. The main sources of hydrocarbon wastes are dilute aqueous solutions that result from various washing procedures during manufacture and use, and hydrocarbon sludges containing varying amounts of the hazardous material in question. Presently the aqueous wastes are discharged into the sewer after skimming and primary treatment to reduce hydrocarbon content. In some parts of the country, discharge directly into rivers and streams is still practiced. The sludges are also landfilled.[0590,0604] Large petrochemical plants incinerate a certain amount of liquid waste.[2480]

A small but significant amount of hydrocarbon wastes are generated in chemical laboratories, small manufacturing plants and various businesses that use them as solvents, cleaners and reaction media but do not have facilities for reclaiming spent solvents. Presently much of this material is picked up by scavengers who dispose of it by reclaiming, landfill, ocean burial, open burning or any other method that seems appropriate.[0596,0604]

Recommended air and water standards are listed below. The air standard is .01 TLV and the water standard is .01 TLV by weight in 2 liters of water. No standards have been recommended for compounds for which TLV's have not been established.

### 1. Aliphatic Hydrocarbons

| Substance | Limit for Air (Man) ppm | Limit for Air (Man) mg/M$^3$ | Limit for Water (Man) ppm or mg/l | Limit for Water (Fish) ppm or mg/l |
|---|---|---|---|---|
| Acetylene | | | | 20 |
| Butadiene | 10 | 22 | 110 | 7.2 |
| Butane | | | | |

Aliphatic Hydrocarbons

| | Limit for Air (Man) | | Limit for Water (Man) | Limit for Water (Fish |
|---|---|---|---|---|
| | ppm | mg/M$^3$ | ppm or mg/l | ppm or mg/l |
| 1-Butene | | | | |
| Butylene | | | | |
| Cyclohexane | | | | |
| Dicyclopentadiene | | | | |
| Disobutylene | | | | |
| Ethane | | | | |
| Ethylene | | | | 2.2 |
| n-Heptane | | | | |
| 1-Heptene | | | | |
| Hexane | | | | |
| Isopentane | | | | |
| Isoprene | | | | |
| Naphtha | | | | |
| Pentane | | | | |
| Propane | | | | |
| Propylene | | | | 100 - 1000 |
| Tetrapropylene | | | | |
| Tripropylene | | | | |
| Turpentine | 1.0 | 5.6 | 28 | 0.1 |

2. Aromatic Hydrocarbons

| | | | | |
|---|---|---|---|---|
| Anthracene | | | | |
| Benzene | .25 | 0.80 | 3.50 | 0.05 |
| Creosote | | | | |
| Cumene | 0.5 | 2.45 | 12.25 | 0.01 - 1.0 |
| Dodecylbenzene | | | | 0.01 - 1.0 |
| Ethylbenzene | 1.0 | 4.35 | 21.75 | 0.50 |
| Naphthalene | 0.10 | 0.50 | 2.50 | 0.10 |
| Styrene | 1.0 | 4.20 | 21.00 | 0.25 |
| Toluene | 1.0 | 3.75 | 18.75 | 0.50 |
| Xylene | 1.0 | 4.35 | 21.75 | 0.10 |

## 5. EVALUATION OF WASTE MANAGEMENT PRACTICES

### Option No.1 - Recycling

The industries that use hydrocarbons as intermediates, solvents or reaction media recycle as much material as possible. A small amount of contaminated solvents from small users is reprocessed for downgraded uses. This should be considered the method of choice whenever possible.

### Option No.2 - Discharge of Dilute Aqueous Solutions into the Municipal or Industrial Sewer After Preliminary Treatment

Hydrocarbons show only slight solubility in water and the amount of dissolved or occluded material can be reduced even further by treatment appropriate to a given compound. In general, hydrocarbons show high resistance to biological degradation, but with the exception of some of the aromatics, they also have a very low toxicity to man, animals, fish and plants. Fortunately, the more toxic aromatics are less persistent than the aliphatics. In spite of these drawbacks, discharge into the municipal or industrial sewer system under controlled conditions is considered as a valid method of disposal. Discharge directly into a stream or river is not acceptable.

### Option No.3 - Incineration

Unreclaimable solvents, solvent mixtures or sludges containing hydrocarbons can be disposed of by incineration. Although not in wide use at present, this is an excellent method because hydrocarbons are easily combusted to carbon dioxide and water. Incineration,being easy and safe, can be performed on site, by scavengers, or at a municipal incineration site.

### Option No.4 - Landfill of Residue, Sludges and Hydrocarbon Mixtures Obtained During Manufacture and Use

Presently hydrocarbon residues, sludges and in some areas hydrocarbon mixtures are landfilled, often at local municipal landfill sites. Since incineration is such an attractive alternative, and because landfill represents a long-term threat to underground water supplies, this option must be considered much less acceptable than Option No.3, incineration.

### Option No.5 - Uncontrolled Disposal by Local Scavengers

Many small and some larger companies contract with local scavengers who then dispose of them by any means that is at hand. Methods include landfill, desert burial, open incineration at remote sites, and ocean burial. The primary motivation in disposal being to get rid of the wastes at minimum cost without being fined. From an ecological point of view, this is totally unacceptable. These scavengers, however, are potentially very valuable since they are capable of concentrating wastes at a few sites where they could be disposed of by sensible means such as Option No.1 (recycling) or Option No.3 (incineration).

## 6. APPLICABILITY TO NATIONAL DISPOSAL SITES

All of the wastes generated by the industries that produce and use these materials can be handled safely and easily locally by incineration. This includes wastes that are presently landfilled by private scavengers. Dilute aqueous wastes can also be handled locally. Therefore, these compounds treated in this report should be considered candidates for industrial or municipal disposal. Incineration at the National Disposal Sites should be necessary only when the waste streams contain, in addition to one or more of the materials cited in this report, other constituents which cause the waste stream to become a candidate for National Disposal Sites.

## 7. REFERENCES

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# HAZARDOUS WASTES PROPERTIES
# WORKSHEET

7

H. M. Name Acetylene

IUC Name ethyne

Common Names

Structural Formula

$HC\equiv CH$

Molecular Wt. 26.04 Melting Pt. -81.8 C(1) Boiling Pt. -86.0 C(1)

Density (Condensed) @ Density (gas) 1.173 g/liter @ 0 C 760mm(1)

Vapor Pressure (recommended 55 C and 20 C)

40 atm @ 16.8 C(1) @ @

Flash Point 0 F (C.C.)(1) Autoignition Temp. 571 F(1)

Flammability Limits in Air (wt %) Lower Upper

Explosive Limits in Air (wt. %) Lower 2.5%(1) Upper 80%(1)

Solubility

Cold Water slightly soluble(2) Hot Water Ethanol

Others: ether,(2) benzene,(2) acetone(2)

Acid, Base Properties

Highly Reactive with

Compatible with

Shipped in

ICC Classification Flammable gas, red gas label(1) Coast Guard Classification red gas label(1)

Comments sublimes at -86.0 C(1); forms explosive compounds with copper and silver.(1)

References (1) 0766
(2) 1492

HAZARDOUS WASTES PROPERTIES
WORKSHEET

54

H. M. Name Benzene

IUC Name benzene

Common Names benzol, coal naphtha

Structural Formula

Molecular Wt. 78.11 Melting Pt. 5.51 C(1) Boiling Pt. 80.093 C(1)

Density (Condensed) 0.8794 @ 20 C(1) Density (gas) 2.77(1) @

Vapor Pressure (recommended 55 C and 20 C)

100 mm @ 26.1 C(1) @ @

Flash Point 12 F (C.C.)(1) Autoignition Temp. 1044 F(1)

Flammability Limits in Air (wt %) Lower Upper

Explosive Limits in Air (wt. %) Lower 1.3%(1) Upper 7.1%(1)

Solubility

Cold Water insoluble(2) Hot Water Ethanol miscible(2)

Others: chloroform,(2) ether,(2) acetone.(2)

Acid, Base Properties

Highly Reactive with

Compatible with

Shipped in

ICC Classification Flammable, red label(1) Coast Guard Classification red label(1)

Comments

References (1) 0766
(2) 14"2

## HAZARDOUS WASTES PROPERTIES WORKSHEET

68

H. M. Name Butadiene-1,3

IUC Name 1,3-butadiene

Common Names

Structural Formula

$CH_2{=}CH{-}CH{=}CH_2$

Molecular Wt. 54.09 Melting Pt. -113 C(1) Boiling Pt. -4.5 C(1)

Density (Condensed) 0.621 @ 20/4 C(1) Density (gas) 1.87 @

Vapor Pressure (recommended 55 C and 20 C)

1840 mm @ 21 C(1) @ @

Flash Point -20 F(1) Autoignition Temp. 804 F(1)

Flammability Limits in Air (wt %) Lower Upper

Explosive Limits in Air (wt. %) Lower 2.0%(1) Upper 11.5%(1)

Solubility

Cold Water Hot Water Ethanol soluble(2)

Others:

Acid, Base Properties

Highly Reactive with

Compatible with

Shipped in

ICC Classification Red label(1) Coast Guard Classification

Comments

References (1) 0766

(2) 1492

69

## HAZARDOUS WASTES PROPERTIES
## WORKSHEET

H. W. Name Butane

IUC Name n-butane

Common Names

Structural Formula

$CH_3(CH_2)_2CH_3$

Molecular Wt. 58.1 Melting Pt. -138.6 C(1) Boiling Pt. -0.5(1)

Density (Condensed) 0.599(1) @ Density (gas) 2.046 @

Vapor Pressure (recommended 55 C and 20 C)

2 atm @ 18.8 C(1) @ @

Flash Point -76 F (C.C.)(1) Autoignition Temp. 761 F(1)

Flammability Limits in Air (wt %) Lower Upper

Explosive Limits in Air (wt. %) Lower 1.9%(1) Upper 8.5%(1)

Solubility

Cold Water insoluble(2) Hot Water Ethanol soluble(2)

Others: ether,(2) chloroform.(2)

Acid, Base Properties

Highly Reactive with

Compatible with

Shipped in

ICC Classification Flammable, red gas label(1) Coast Guard Classification red gas label(1)

Comments

References (1) 0766

(2) 1492

## HAZARDOUS WASTES PROPERTIES
## WORKSHEET

71

H. M. Name 1-Butene

IUC Name 1-butene

Common Names

Structural Formula

$CH_3CH_2CH=CH_2$

Molecular Wt. 56.10 Melting Pt. -185.3 C(1) Boiling Pt. -6.3 C(1)

Density (Condensed) 0.668 @ 0/1 C(1) Density (gas) 1.93(1) @

Vapor Pressure (recommended 55 C and 20 C)

3480 mm @ 21 C(1) @ @

Flash Point -112 F(1) Autoignition Temp. 723 F(1)

Flammability Limits in Air (wt %) Lower Upper

Explosive Limits in Air (wt. %) Lower 1.7%(1) Upper 9.0%(1)

Solubility

Cold Water Hot Water Ethanol

Others:

Acid, Base Properties

Highly Reactive with

Compatible with

Shipped in

ICC Classification Coast Guard Classification

Comments IATA - Flammable, red gas label.(1)

References (1) 0766

76-A

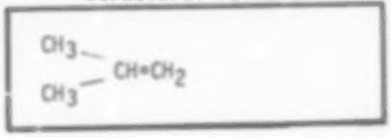
## HAZARDOUS WASTES PROPERTIES
## WORKSHEET

H. M. Name Butylenes

IUC Name 2-methylpropene

Common Names isobutene

Structural Formula



$$\begin{matrix} CH_3 \\ CH_3 \end{matrix} \rangle CH{=}CH_2$$

Molecular Wt. 56.1 Melting Pt. -140.3 C(1) Boiling Pt. -6.9 C(1)

Density (Condensed) 0.600(1) @ Density (gas) 1.94(1) @

Vapor Pressure (recommended 55 C and 20 C)

3290 mm @ 40.5 C(1) @ @

Flash Point <20 F(1) Autoignition Temp. 869 F(1)

Flammability Limits in Air (wt %) Lower Upper

Explosive Limits in Air (wt. %) Lower 1.8%(1) Upper 8.8%(1)

Solubility

Cold Water Hot Water Ethanol

Others:

Acid, Base Properties

Highly Reactive with

Compatible with

Shipped in

ICC Classification Coast Guard Classification

Comments

References (1) 0766

HAZARDOUS WASTES PROPERTIES
WORKSHEET

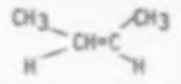
76-8

H. M. Name Butylenes

IUC Name cis-2-butene

Common Names

Structural Formula



Molecular Wt. 56.1 Melting Pt. -139 C(1) Boiling Pt. 1 C(1)

Density (Condensed) 0.627 @ 15.5/15.5 C(1) Density (gas) 1.9(1) @

Vapor Pressure (recommended 55 C and 20 C)

1410 mm @ 21 C(1) @ @

Flash Point -20 F(1) Autoignition Temp. 615 F(1)

Flammability Limits in Air (wt %) Lower Upper

Explosive Limits in Air (wt. %) Lower 1.7%(1) Upper 9.0%(1)

Solubility

Cold Water Hot Water Ethanol

Others:

Acid, Base Properties

Highly Reactive with

Compatible with

Shipped in

ICC Classification Coast Guard Classification

Comments

References (1) 0766

76-C

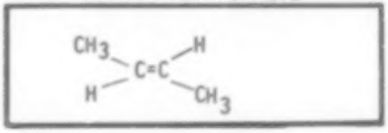
## HAZARDOUS WASTES PROPERTIES WORKSHEET

H. M. Name Butylenes

IUC Name trans-2-butene

Common Names

Structural Formula



Molecular Wt. 56.1 Melting Pt. -105.6 C(1) Boiling Pt. 2.5 C(1)

Density (Condensed) 0.613 @ 15.5/15.5 C(1) Density (gas) 1.95(1) @

Vapor Pressure (recommended 55 C and 20 C)

1592 mm @ 21 C(1) @ @

Flash Point <20 F(1) Autoignition Temp. 615 F(1)

Flammability Limits in Air (wt %) Lower Upper

Explosive Limits in Air (wt. %) Lower 1.8%(1) Upper 9.7%(1)

Solubility

Cold Water Hot Water Ethanol

Others:

Acid, Base Properties

Highly Reactive with

Compatible with

Shipped in

ICC Classification Coast Guard Classification

Comments

References (1) 0766

HAZARDOUS WASTES PROPERTIES
WORKSHEET

123

H. M. Name Creosote, Coal Tar

IUC Name creosote oil

Common Names

Structural Formula

None

Molecular Wt. Melting Pt. Boiling Pt. 200-250 C(1)

Density (Condensed) 1.07 (1) @ Density (gas) @

Vapor Pressure (recommended 55 C and 20 C)

@ @ @

Flash Point 165 F (C.C.)(1) Autoignition Temp. 637 F(1)

Flammability Limits in Air (wt %) Lower Upper

Explosive Limits in Air (wt. %) Lower Upper

Solubility

Cold Water insoluble(2) Hot Water Ethanol

Others:

Acid, Base Properties

Highly Reactive with

Compatible with

Shipped in

ICC Classification Coast Guard Classification Combustible(1)

Comments Mixture of phenols from coal tar.(1)

References (1) 0766
(2) 1492

## HAZARDOUS WASTES PROPERTIES
## WORKSHEET

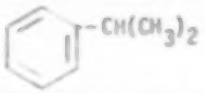
127

H. M. Name Cumene

IUC Name isopropyl benzene

Common Names Cumol, 2-phenylpropane

Structural Formula



Molecular Wt. 120.19 Melting Pt. -96.0 C(1) Boiling Pt. 152 C(1)

Density (Condensed) 0.864 @ 20/4 C Density (gas) 4.1 @ ______ ______

Vapor Pressure (recommended 55 C and 20 C)

10 mm @ 38.3 C(1) ______ @ ______ ______ @ ______

Flash Point 111 F(1) Autoignition Temp. 795 F(1)

Flammability Limits in Air (wt %) Lower ______ Upper ______

Explosive Limits in Air (wt. %) Lower 0.9%(1) Upper 6.5%(1)

Solubility

Cold Water insoluble(2) Hot Water ______ Ethanol soluble(2)

Others: ______

Acid, Base Properties ______

Highly Reactive with ______

Compatible with ______

Shipped in ______

ICC Classification ______ Coast Guard Classification ______

Comments ______

References (1) 0766
(2) 1492

131

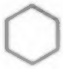
## HAZARDOUS WASTES PROPERTIES
## WORKSHEET

H. M. Name Cyclohexane

IUC Name cyclohexane

Common Names hexamethylene

Structural Formula



Molecular Wt. 84.16 Melting Pt. 6.5 C(1) Boiling Pt. 80.7 C(1)

Density (Condensed) 0.7791 @ 20/4 C(1) Density (gas) 2.90 @

Vapor Pressure (recommended 55 C and 20 C)

100 mm @ 60.8 C(1) @ @

Flash Point -4 F(1) Autoignition Temp. 500 F(1)

Flammability Limits in Air (wt %) Lower Upper

Explosive Limits in Air (wt. %) Lower 1.3%(1) Upper 8.4%(1)

Solubility

Cold Water Hot Water Ethanol

Others:

Acid, Base Properties

Highly Reactive with

Compatible with

Shipped in

ICC Classification Flammable, red label(1) Coast Guard Classification red label(1)

Comments

References (1) 0766

## HAZARDOUS WASTES PROPERTIES
## WORKSHEET

148

H. M. Name Dicyclopentadiene

IUC Name α-dicyclopentadiene

Common Names

Structural Formula

$C_{10}H_{12}$

Molecular Wt. 132.2 Melting Pt. 32.9 C(1) Boiling Pt. 166.6 C(1)

Density (Condensed) 0.976 @ 35 C(1) Density (gas) 4.55(1) @

Vapor Pressure (recommended 55 C and 20 C)

10 mm @ 47.6 C(1) @ @

Flash Point 90 F (O.C.)(1) Autoignition Temp.

Flammability Limits in Air (wt %) Lower Upper

Explosive Limits in Air (wt. %) Lower Upper

Solubility

Cold Water Hot Water Ethanol

Others:

Acid, Base Properties

Highly Reactive with

Compatible with

Shipped in

ICC Classification Coast Guard Classification

Comments

References (1) 0766

156

## HAZARDOUS WASTES PROPERTIES
## WORKSHEET

H. M. Name Diisobutylene

IUC Name

Common Names

Structural Formula

$C_8H_{16}$

Molecular Wt. 112.2 Melting Pt. ~ 101 C(1) Boiling Pt. 102 C(1)

Density (Condensed) 0.7227 @ 15.6 C(1) Density (gas) 3.97 @

Vapor Pressure (recommended 55 C and 20 C)

@ @ @

Flash Point 20 F (C.C.)(1) Autoignition Temp.

Flammability Limits in Air (wt %) Lower Upper

Explosive Limits in Air (wt. %) Lower Upper

Solubility

Cold Water Hot Water Ethanol

Others:

Acid, Base Properties

Highly Reactive with

Compatible with

Shipped in

ICC Classification Coast Guard Classification

Comments

References (1) 0766

## HAZARDOUS WASTES PROPERTIES
## WORKSHEET

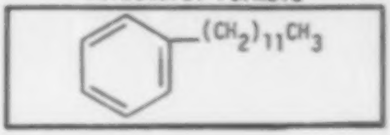
169

H. M. Name Dodecylbenzene

IUC Name dodecylbenzene

Common Names

Structural Formula



Molecular Wt. 246.4 Melting Pt. Boiling Pt. 290-410 C(1)

Density (Condensed) 0.9(1) @ Density (gas) 8.47 @

Vapor Pressure (recommended 55 C and 20 C)

@ @ @

Flash Point 285 F(1) Autoignition Temp.

Flammability Limits in Air (wt %) Lower Upper

Explosive Limits in Air (wt. %) Lower Upper

Solubility

Cold Water Hot Water Ethanol

Others:

Acid, Base Properties

Highly Reactive with

Compatible with

Shipped in

ICC Classification Coast Guard Classification

Comments

References (1) 0766

179

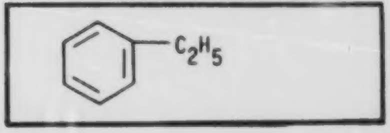
## HAZARDOUS WASTES PROPERTIES
## WORKSHEET

H. M. Name Ethylbenzene

IUC Name ethylbenzene

Common Names phenylethane, ethylbenzol -

Structural Formula



Molecular Wt. 106.16

Melting Pt. -94.9 C(1)

Boiling Pt. 136.2 C(1)

Density (Condensed) 0.8669 @ 20/4 C(1)

Density (gas) 3.66 @

Vapor Pressure (recommended 55 C and 20 C)

10 mm @ 25.9 C(1)

@

@

Flash Point 59 F(1)

Autoignition Temp. 810 F(1)

Flammability Limits in Air (wt %) Lower Upper

Explosive Limits in Air (wt. %) Lower Upper

Solubility

Cold Water

Hot Water

Ethanol

Others:

Acid, Base Properties

Highly Reactive with

Compatible with

Shipped in

ICC Classification

Coast Guard Classification Combustible(1)

Comments IATA - Flammable, red label.(1)

References (1) 0766

181

## HAZARDOUS WASTES PROPERTIES
## WORKSHEET

H. M. Name Ethylene

IUC Name ethene

Common Names etherin

Structural Formula

$CH_2=CH_2$

Molecular Wt. 28.05 Melting Pt. -169.4 C(1) Boiling Pt. -103.9 C(1)

Density (Condensed) 0.610 @ 0 C(1) Density (gas) 0.98 @

Vapor Pressure (recommended 55 C and 20 C)

@ @ @

Flash Point Autoignition Temp. 842

Flammability Limits in Air (wt %) Lower Upper

Explosive Limits in Air (wt. %) Lower 3.1%(1) Upper 32%(1)

Solubility

Cold Water insoluble(2) Hot Water Ethanol slightly soluble(1)

Others: ether,(2) acetone,(2) benzene.(2)

Acid, Base Properties

Highly Reactive with

Compatible with

Shipped in

ICC Classification Flammable, red label(1) Coast Guard Classification red label(1)

Comments

References (1) 0766

(2) 1492

## HAZARDOUS WASTES PROPERTIES WORKSHEET

207

H. M. Name n-Heptane

IUC Name n-heptane

Common Names

Structural Formula

$CH_3(CH_2)_5CH_3$

Molecular Wt. 100.20 Melting Pt. -90.5 C(1) Boiling Pt. 98.52 C(1)

Density (Condensed) 0.684 @ 20/4 C(1) Density (gas) 3.45 @

Vapor Pressure (recommended 55 C and 20 C)

40 mm @ 22.3 C(1) @ @

Flash Point 25 F (C.C.)(1) Autoignition Temp. 433 C

Flammability Limits in Air (wt %) Lower Upper

Explosive Limits in Air (wt. %) Lower 1.2%(1) Upper 6.7%(1)

Solubility

Cold Water insoluble(2) Hot Water Ethanol soluble(2)

Others: chloroform, ether(2)

Acid, Base Properties

Highly Reactive with

Compatible with

Shipped in

ICC Classification Flammable, red label(1) Coast Guard Classification red label(1)

Comments

References (1) 0766
(2) 1492

HAZARDOUS WASTES PROPERTIES
WORKSHEET

208

H. M. Name 1-Heptene

IUC Name 1-heptene

Common Names α-heptylene

Structural Formula

$CH_2{=}CH(CH_2)_4CH_3$

Molecular Wt. 98.2 Melting Pt. -10 C(1) Boiling Pt. 93.6 C(1)

Density (Condensed) 0.6969 @ Density (gas) @

Vapor Pressure (recommended 55 C and 20 C)

@ @ @

Flash Point Autoignition Temp.

Flammability Limits in Air (wt %) Lower Upper

Explosive Limits in Air (wt. %) Lower Upper

Solubility

Cold Water Hot Water Ethanol

Others:

Acid, Base Properties

Highly Reactive with

Compatible with

Shipped in

ICC Classification Coast Guard Classification

Comments

References (1) 0766

## HAZARDOUS WASTES PROPERTIES WORKSHEET

211

H. M. Name n-Hexane

IUC Name n-hexane

Common Names

Structural Formula

$CH_3(CH_2)_4CH_3$

Molecular Wt. 86.17 Melting Pt. -95.6 C(1) Boiling Pt. 68.7 C(1)

Density (Condensed) 0.6603 @ 20/4 C(1) Density (gas) 2.97 @

Vapor Pressure (recommended 55 C and 20 C)

10 mm @ 15.8 C(1) @ @

Flash Point -7 F(1) Autoignition Temp. 500 F(1)

Flammability Limits in Air (wt %) Lower Upper

Explosive Limits in Air (wt. %) Lower 1.2%(1) Upper 7.5%(1)

Solubility

Cold Water insoluble(2) Hot Water Ethanol miscible(2)

Others: chloroform, ether(2)

Acid, Base Properties

Highly Reactive with

Compatible with

Shipped in

ICC Classification Flammable, red label(1) Coast Guard Classification red label(1)

Comments

References (1) 0766
(2) 1492

## HAZARDOUS WASTES PROPERTIES WORKSHEET

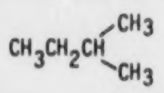
225

H. M. Name Isopentane

IUC Name 2-methylbutane

Common Names

Structural Formula



$CH_3CH_2CH(CH_3)CH_3$

Molecular Wt. 72.15 Melting Pt. -160.5 C(1) Boiling Pt. 27.8 C(1)

Density (Condensed) 0.621 @ 20/4 C(1) Density (gas) 2.48 @

Vapor Pressure (recommended 55 C and 20 C)

595 mm @ 21.1 C(1) @ @

Flash Point <-60 F (C.C.)(1) Autoignition Temp. 788 F(1)

Flammability Limits in Air (wt %) Lower Upper

Explosive Limits in Air (wt. %) Lower 1.4%(1) Upper 7.6%(1)

Solubility

Cold Water Hot Water Ethanol

Others:

Acid, Base Properties

Highly Reactive with

Compatible with

Shipped in

ICC Classification Flammable, red label(1) Coast Guard Classification red label(1)

Comments

References (1) 0766

## HAZARDOUS WASTES PROPERTIES WORKSHEET

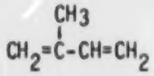
227

H. M. Name Isoprene

IUC Name 2-methyl-1,3-butadiene

Common Names

Structural Formula



$CH_2=C(CH_3)-CH=CH_2$

Molecular Wt. 68.11     Melting Pt. -146.7 C(1)     Boiling Pt. 34 C(1)

Density (Condensed) 0.6806 @ 20/4 C(1) Density (gas) 2.35 @

Vapor Pressure (recommended 55 C and 20 C)

400 mm @ 15.4 C(1)     @     @

Flash Point -65 F(1)     Autoignition Temp. 428 F(1)

Flammability Limits in Air (wt %)     Lower     Upper

Explosive Limits in Air (wt. %)     Lower     Upper

Solubility

Cold Water insoluble(2)     Hot Water     Ethanol miscible(2)

Others: ether(2)

Acid, Base Properties

Highly Reactive with

Compatible with

Shipped in

ICC Classification Flammable, red label(1)     Coast Guard Classification red label(1)

Comments

References (1) 0766

(2) 1492

HAZARDOUS WASTES PROPERTIES
WORKSHEET

254

H. M. Name Propane

IUC Name propane

Common Names

Structural Formula

$CH_3CH_2CH_3$

Molecular Wt. 44.09 Melting Pt. -187.1 C(1) Boiling Pt. -42.1 C(1)

Density (Condensed) 0.5852 @-44.5/4 C(1) Density (gas) 1.56 @

Vapor Pressure (recommended 55 C and 20 C)

@ @ @

Flash Point 156 F(1) Autoignition Temp. 874 F(1)

Flammability Limits in Air (wt %) Lower Upper

Explosive Limits in Air (wt. %) Lower 2.3%(1) Upper 9.5%(1)

Solubility

Cold Water Hot Water Ethanol soluble(2)

Others:

Acid, Base Properties

Highly Reactive with

Compatible with

Shipped in

ICC Classification Coast Guard Classification

Comments

References (1) 0766
(2) 1492

## HAZARDOUS WASTES PROPERTIES
## WORKSHEET

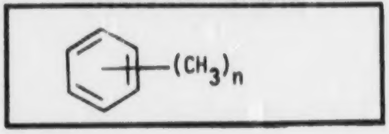
284

H. M. Name Naphtha (Coal Tar)

IUC Name Hi-flash naphtha

Common Names

Structural Formula



Molecular Wt. Melting Pt. Boiling Pt. 149-21 C(1)

Density (Condensed) 0.862-0.892(1) @ Density (gas) @

Vapor Pressure (recommended 55 C and 20 C)

@ @ @

Flash Point 100 F (C.C.)(1) Autoignition Temp. 900-950 F(1)

Flammability Limits in Air (wt %) Lower Upper

Explosive Limits in Air (wt. %) Lower Upper

Solubility

Cold Water Hot Water Ethanol

Others:

Acid, Base Properties

Highly Reactive with

Compatible with

Shipped in

ICC Classification Flammable, red label(1) Coast Guard Classification red label(1)

Comments Mixture of benzene, toluene, xylene, etc.(1)

References (1) 0766

## HAZARDOUS WASTES PROPERTIES WORKSHEET

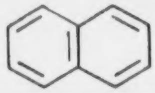
285

H. M. Name Naphthalene

IUC Name naphthalene

Common Names

Structural Formula



Molecular Wt. 128.16 Melting Pt. 80.1 C(1) Boiling Pt. 217.9 C(1)

Density (Condensed) 1.145 C(1) @ Density (gas) 4.42 @

Vapor Pressure (recommended 55 C and 20 C)

1 mm @ 52.6 C(1) @ @

Flash Point 176 F(1) Autoignition Temp. 979 F(1)

Flammability Limits in Air (wt %) Lower Upper

Explosive Limits in Air (wt. %) Lower 0.9%(1) Upper 5.9%(1)

Solubility

Cold Water insoluble(2) Hot Water Ethanol soluble(2)

Others: benzene(2)

Acid, Base Properties

Highly Reactive with

Compatible with

Shipped in

ICC Classification I.A.T.A.: Flammable solid, yellow label(1) Coast Guard Classification hazardous

Comments Sublimes at 217.9 C(1).

References (1) 0766
(2) 1492

HAZARDOUS WASTES PROPERTIES
WORKSHEET

323

H. M. Name n-Pentane

IUC Name n-pentane

Common Names

Structural Formula

$CH_3(CH_2)_3CH_3$

Molecular Wt. 72.15 Melting Pt. -129.8 C(1) Boiling Pt. 36.1 C(1)

Density (Condensed) 0.626 @ 20/4 C(1) Density (gas) 2.48 @

Vapor Pressure (recommended 55 C and 20 C)

400 mm @ 18.5 C(1) @ @

Flash Point <-40 F(1) Autoignition Temp. 588 F(1)

Flammability Limits in Air (wt %) Lower Upper

Explosive Limits in Air (wt. %) Lower 1.5%(1) Upper 7.8%(1)

Solubility

Cold Water insoluble(2) Hot Water Ethanol miscible(2)

Others: ether(2)

Acid, Base Properties

Highly Reactive with

Compatible with

Shipped in

ICC Classification Flammable, red label(1) Coast Guard Classification red label(1)

Comments

References (1) 0766

(2) 1492

## HAZARDOUS WASTES PROPERTIES
## WORKSHEET

360

H. M. Name Propylene

IUC Name propene

Common Names

Structural Formula

$CH_2= CHCH_3$

Molecular Wt. 42.1    Melting Pt. -185 C(1)    Boiling Pt. -47.7 C(1)

Density (Condensed) 0.581 @ 0 C(1)    Density (gas) 1.5 @

Vapor Pressure (recommended 55 C and 20 C)

10 atm @ 19.8 C(1)    @    @

Flash Point    Autoignition Temp. 927 F(1)

Flammability Limits in Air (wt %)    Lower    Upper

Explosive Limits in Air (wt. %)    Lower 2.0%(1)    Upper 11.1%(1)

Solubility

Cold Water    Hot Water    Ethanol

Others:

Acid, Base Properties

Highly Reactive with

Compatible with

Shipped in

ICC Classification Flammable gas label(1)    Coast Guard Classification red gas label(1)

Comments

References (1) 0766

## HAZARDOUS WASTES PROPERTIES
## WORKSHEET

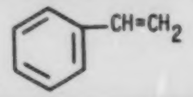
412

H. M. Name Styrene

IUC Name ethenylbenzene

Common Names vinyl benzene, cinnamene

Structural Formula



Molecular Wt. 104.14 Melting Pt. -31 C(1) Boiling Pt. 146 C(1)

Density (Condensed) 0.9074 @ 20/4 C(1) Density (gas) 3.6 @

Vapor Pressure (recommended 55 C and 20 C)

@ @ @

Flash Point 88 F(1) Autoignition Temp. 914 F (1)

Flammability Limits in Air (wt %) Lower Upper

Explosive Limits in Air (wt. %) Lower 1.1%(1) Upper 6.1%(1)

**Solubility**

Cold Water slightly soluble(2) Hot Water Ethanol soluble(2)

Others: ether, acetone(2)

Acid, Base Properties

Highly Reactive with

Compatible with

Shipped in

ICC Classification Coast Guard Classification

Comments

References (1) 0766
(2) 1492

## HAZARDOUS WASTES PROPERTIES
## WORKSHEET

429

H. M. Name Tetrapropylene

IUC Name

Common Names

Structural Formula

$(CH_2CHCH_2)_4$

Molecular Wt. 168.32 Melting Pt. Boiling Pt.

Density (Condensed) @ Density (gas) @

Vapor Pressure (recommended 55 C and 20 C)

@ @ @

Flash Point Autoignition Temp.

Flammability Limits in Air (wt %) Lower Upper

Explosive Limits in Air (wt. %) Lower Upper

Solubility

Cold Water insoluble Hot Water Ethanol

Others: benzene

Acid, Base Properties

Highly Reactive with

Compatible with

Shipped in

ICC Classification Coast Guard Classification

Comments

References

## HAZARDOUS WASTES PROPERTIES WORKSHEET

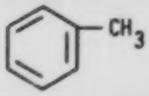
434

H. M. Name Toluene

IUC Name methyl benzene

Common Names phenyl methane

Structural Formula



Molecular Wt. 92.13 Melting Pt. -95 C(1) Boiling Pt. 110.4 C(1)

Density (Condensed) 0.866 @ 20/4 C(1) Density (gas) 3.14(1) @

Vapor Pressure (recommended 55 C and 20 C)

36.7 mm @ 30 C(1) @ @

Flash Point 40 F (C.C.)(1) Autoignition Temp. 947 F(1)

Flammability Limits in Air (wt %) Lower Upper

Explosive Limits in Air (wt. %) Lower 1.27%(1) Upper 7.0%(1)

Solubility

Cold Water insoluble(2) Hot Water Ethanol miscible(2)

Others: chloroform, ether, acetone(2)

Acid, Base Properties

Highly Reactive with

Compatible with

Shipped in

ICC Classification Flammable, red label(1) Coast Guard Classification red label(1)

Comments

References (1) 0766
(2) 1492

## HAZARDOUS WASTES PROPERTIES
## WORKSHEET

446

H. M. Name Tripropylene

IUC Name ____

Common Names ____

Structural Formula

$(CH_2CHCH_2)_3$

Molecular Wt. 126.24 Melting Pt. ____ Boiling Pt. ____

Density (Condensed) ____ @ ____ ____ Density (gas) ____ @ ____ ____

Vapor Pressure (recommended 55 C and 20 C)

____ @ ____ ____ @ ____ ____ @ ____

Flash Point ____ Autoignition Temp. ____

Flammability Limits in Air (wt %) Lower ____ Upper ____

Explosive Limits in Air (wt. %) Lower ____ Upper ____

Solubility

Cold Water insoluble Hot Water ____ Ethanol ____

Others: benzene

Acid, Base Properties ____

Highly Reactive with ____

Compatible with ____

Shipped in ____

ICC Classification ____ Coast Guard Classification ____

Comments ____

References

## HAZARDOUS WASTES PROPERTIES WORKSHEET

447

H. M. Name Turpentine Oil

IUC Name

Common Names spirit of turpentine

Structural Formula

$C_{10}H_{16}$

Molecular Wt. 136

Melting Pt.

Boiling Pt. 154-170 C(1)

Density (Condensed) 0.854-0.868 @ 25/25 C(1)

Density (gas) 4.84 @

Vapor Pressure (recommended 55 C and 20 C)

@

@

@

Flash Point 95 F (C.C.)(1)

Autoignition Temp. 488 F(1)

Flammability Limits in Air (wt %) Lower Upper

Explosive Limits in Air (wt. %) Lower 0.8%(1) Upper

Solubility

Cold Water insoluble(2)

Hot Water

Ethanol soluble(2)

Others: benzene, chloroform(2)

Acid, Base Properties

Highly Reactive with

Compatible with

Shipped in

ICC Classification

Coast Guard Classification combustible liquid(1)

Comments

References (1) 0766

(2) 1492

## HAZARDOUS WASTES PROPERTIES WORKSHEET

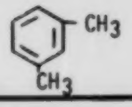
451-A

H. M. Name m-Xylene

IUC Name 1,3-dimethyl benzene

Common Names m-xytol

Structural Formula



Molecular Wt. 106.2 Melting Pt. -47.9 C(1) Boiling Pt. 139 C(1)

Density (Condensed) 0.864 @ 20/4 C(1) Density (gas) 3.66(1) @

Vapor Pressure (recommended 55 C and 20 C)

10 mm @ 28.3 C(1) @ @

Flash Point Autoignition Temp. 982 F(1)

Flammability Limits in Air (wt %) Lower Upper

Explosive Limits in Air (wt. %) Lower 1.1%(1) Upper 7.0%(1)

Solubility

Cold Water insoluble(2) Hot Water Ethanol miscible(2)

Others: ether(2)

Acid, Base Properties

Highly Reactive with

Compatible with

Shipped in

ICC Classification Flammable, red label(1) Coast Guard Classification red label(1)

Comments

References (1) 0766
(2) 1492

451-B

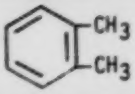
## HAZARDOUS WASTES PROPERTIES
## WORKSHEET

H. M. Name o-Xylene

IUC Name 1.2-dimethyl benzene

Common Names o-xytol

Structural Formula



Molecular Wt. 106.2 Melting Pt. -29.5 C(1) Boiling Pt. 144.4(1)

Density (Condensed) 0.880 @ 20/4 C(1) Density (gas) 3.66(1) @

Vapor Pressure (recommended 55 C and 20 C)

10 mm @ 32.1 C(1) @ @

Flash Point 90 F(1) Autoignition Temp. 867 F(1)

Flammability Limits in Air (wt %) Lower Upper

Explosive Limits in Air (wt. %) Lower 1.0%(1) Upper 6.0%(1)

Solubility

Cold Water insoluble(2) Hot Water Ethanol miscible(2)

Others: ether(2)

Acid, Base Properties

Highly Reactive with

Compatible with

Shipped in

ICC Classification Flammable, red label(1) Coast Guard Classification red label(1)

Comments

References (1) 0766

(2) 1492

HAZARDOUS WASTES PROPERTIES
WORKSHEET

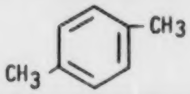
451-C

H. M. Name p-Xylene

IUC Name 1.4-dimethyl benzene

Common Names p-xytol

Structural Formula



Molecular Wt. 106.2 Melting Pt. 13.2 C(1) Boiling Pt. 138.3 C(1)

Density (Condensed) 0.86(1) @ 20/4 C(1) Density (gas) 3.66(1) @

Vapor Pressure (recommended 55 C and 20 C)

10 mm @ 27.3 C(1) @ @

Flash Point 103 F (IOC)(1) Autoignition Temp.

Flammability Limits in Air (wt %) Lower Upper

Explosive Limits in Air (wt. %) Lower 1.1%(1) Upper 7.0%(1)

Solubility

Cold Water insoluble(2) Hot Water Ethanol soluble(2)

Others: ether(2)

Acid, Base Properties

Highly Reactive with

Compatible with

Shipped in

ICC Classification Flammable, red label(1) Coast Guard Classification red label(1)

Comments

References (1) 0766
(2) 1492

## HAZARDOUS WASTES PROPERTIES WORKSHEET

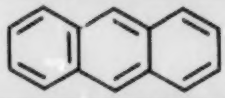
466

H. M. Name Anthracene

IUC Name anthracene

Common Names green oil

Structural Formula



Molecular Wt. 178.22 Melting Pt. 217 C(1) Boiling Pt. 345 C(1)

Density (Condensed) 1.25 @ 27/4 C(1) Density (gas) 6.15 @

Vapor Pressure (recommended 55 C and 20 C)

1 mm @ 145.0 C(1) @ @

Flash Point 250 F (C.C.)(1) Autoignition Temp. 881 F(1)

Flammability Limits in Air (wt %) Lower Upper

Explosive Limits in Air (wt. %) Lower 0.6%(1) Upper

Solubility

Cold Water insoluble(2) Hot Water Ethanol slightly soluble(1)

Others:

Acid, Base Properties

Highly Reactive with

Compatible with

Shipped in

ICC Classification Coast Guard Classification

Comments Sublimes at 145 C(1)

References (1) 0766
(2) 1492

## HAZARDOUS WASTES PROPERTIES
## WORKSHEET

493

H. M. Name Ethane

IUC Name ethane

Common Names dimethyl

Structural Formula

$CH_3CH_3$

Molecular Wt. 30.07 Melting Pt. -172 C(1) Boiling Pt. -88.6 C(1)

Density (Condensed) 0.446 @ 0 C(1) Density (gas) 1.04 @

Vapor Pressure (recommended 55 C and 20 C)

@ @ @

Flash Point Autoignition Temp. 959 F(1)

Flammability Limits in Air (wt %) Lower Upper

Explosive Limits in Air (wt. %) Lower 3.0%(1) Upper 12.5%(1)

Solubility

Cold Water insoluble(2) Hot Water Ethanol slightly soluble(2)

Others:

Acid, Base Properties

Highly Reactive with

Compatible with

Shipped in

ICC Classification Flammable, red gas label(1) Coast Guard Classification red gas label(1)

Comments

References (1) 0766
(2) 1492

# PROFILE REPORT

# CARBOXYLIC ACIDS

## Acrylic Acid (10), Adipic Acid (12), Benzoic Acid (57), Fatty Acids (197), Formic Acid (202), Propionic Acid (356), Salicylic Acid (366).

## 1. GENERAL

### Introduction

The carboxylic acids treated in this report have all been selected as probable candidates for municipal disposal. These materials are similar in that most are commodity chemicals with low toxicity, well-defined and safe methods of industrial handling, and common methods of disposal. The carboxylic acids are, therefore, discussed as a class in this report.

For a discussion of the manufacture, uses and toxicological properties of the fatty acids and formic acid, one should refer to the Profile Reports on oleic acid (316) and sodium formate (390).

### Manufacture

Benzoic, adipic and propionic acids are manufactured by catalytic oxidation procedures. Benzoic acid is made from toluene, adipic acid from cyclohexanol, and propionic acid from propane, butane or a mixed feed. Salicylic acid is produced by the Kolbe-Schmitt reaction of sodium phenolate with carbon dioxide. Acrylic acid is made by several procedures including the hydrolysis of ethylene cyanohydrin; the destructive distillation of β-propriolactone; from acetylene, carbon monoxide and water in the presence of nickel carbonyl; the hydrolysis of acrylonitrile; and the catalytic oxidation of propylene.[1433,1501]

### Uses[1433,1506]

Benzoic acid is used as a food additive (44%), as a plasticizer (36%), in alkyd resins (10%) and in pharmaceuticals, flavorings and miscellaneous uses (10%). The major use of adipic acid is the production of nylon 6/6 (88%); other uses,such as esters for plasticizers and synthetic lubes, and in urethans account for the remainder. Propionic acid is used as a preservative and cattle feed additive in the form of the calcium and sodium salts (45%), cellulose propionate plastics (30%), and in herbicides and miscellaneous uses (6%). Salicylic acid is used in aspirin (65%), medicinals (15%), as a rubber retarder and dye intermediate (10%), and in miscellaneous uses (10%). Acrylic acid is used in paint lattices (48%), textile manufacture (15%), acrylic fiber (6%), acrylic specialties (7%), and in miscellaneous uses (14%). Most acrylic acid is used as the ethyl, butyl and other esters.

### Physical and Chemical Properties

The physical and chemical properties of the compounds discussed in this report are included in the attached worksheets.

## 2. TOXICOLOGY[0766]

With the exception of acrylic acid and formic acid (see Profile Report on sodium formate [390]), the carboxylic acids in this report show a very low order of toxicity. In fact, they are all used as preservatives and/or medicinals, and can be ingested directly with neutral or positive effects. Propionic acid is a relatively strong acid and its corrosive effects are similar to those of acetic acid. The sodium and calcium salts are innocuous. The toxic action of acrylic acid has not been investigated throroughly. However, it is a very strong irritant to the eyes, mucuous membranes and respiratory system.

The Threshold Limit Values (TLV) and Maximum Allowable Concentrations (MAC) that have been established are:

| Substance | TLV ppm | TLV mg/M$^3$ | MAC ppm |
|---|---|---|---|
| Acrylic acid | | | |
| Adipic acid | | | |
| Benzoic acid | | | |
| Fatty acids | | | |
| Formic acid | 5 | 9 | |
| Propionic acid | | | |
| Salicylic acid | | | |

## 3. OTHER HAZARDS

Under the proper conditions,such as the presence of oxygen or other polymerization initiator and heat, acrylic acid and its esters can polymerize violently.[0766,1433]

## 4. DEFINITION OF WASTE MANAGEMENT PRACTICES

### Handling, Storage and Transportation

Acrylic, propionic and formic acids are all toxic to a certain extent due to the corrosive action of the liquid or vapors, especially in the sensitive areas of the eyes, mucuous membranes and the respiratory tract. Thus, they should be handled in a well-ventilated area and protective clothing and respirators are recommended where necessary. In cases of accidental contact, all contaminated clothing should be removed and the skin washed with soap and water. The remaining compounds are solids and present no particular hazard.

These materials are shipped under a variety of U.S. Department of Transportation, Coast Guard and IATA regulations. Most regulations relate to the flammability and corrosiveness of these compounds. Information on safe handling and use of these compounds can be found in standard reference sources or manufacturers' Technical Data Sheets.

### Disposal/Reuse

Manufacturers who use the carboxylic acids as chemical intermediates recycle any unused material. Material used as food additives and medicinals is consumed by the public and not recoverable. A substantial amount of the acids in this group are used to produce plasticizers, resins, paint lattices or plastics. This material is not recoverable.

Many of the various manufacturing processes result in dilute carboxylic acid containing waste streams which have a high chemical and biological oxygen demand[0295,1543] and a low pH due to their acidity. They can be treated on site or discharged into the municipal sewer after pH adjustment.

Recommended air and water standards are listed below. The air standard is .01 TLV and the water standard is .01 TLV by weight in 2 liters of water in the absence of independent data. No standards have been recommended for compounds for which TLV's have not been established.

| Substance | Limit for Air (Man) | | Limit for Water (Man) | Limit for Water (Fish) |
|---|---|---|---|---|
| | ppm | mg/M$^3$ | ppm or mg/l | ppm or mg/O |
| Acrylic acid | | | | 0.1 - 10 |
| Adipic acid | | | | 80 |
| Benzoic acid | | | | 18 |
| Fatty acids | | | | |
| Formic acid | 0.05 | 0.09 | 0.45 | 470 |
| Propionic acid | | | | 10 |
| Salicylic acid | | | | 150 |

## 5. EVALUATION OF WASTE MANAGEMENT PRACTICES

### Option No.1 - Recycling

Manufacturers that use carboxylic acids as chemical intermediates recycle as much material as possible. In addition, a certain amount of contaminated acids are eligible for reprocessing. This is the method of choice wherever possible.

### Option No.2 - Treatment of Waste Water to Reduce Chemical and Biological Oxygen Demand

The carboxylic acids treated in this report have not only a very low level of toxicity but they can be biodegraded very rapidly by unacclimated activated sludges. This is due in part to the fact that they are the same as or very similar to carboxylic acids present in normal sewage. Thus, the best method of disposal is via municipal sewage treatment plants provided the rate of discharge is uniform and the pH is in the proper range (6.0 to 9.0).

### Option No.3 - Incineration

Bulk quantities of contaminated carboxylic acids that can not be reprocessed or released by controlled dilution can best be disposed of by incineration. Since this will probably be an unusual occurrence, this is best done at municipal incineration sites.

## 6. APPLICABILITY TO NATIONAL DISPOSAL SITES

All of the wastes generated by the industries that produce and use the carboxylic acids treated in this report can be handled by municipal disposal either by sewage treatment or incineration. Disposal is so easy and safe that use of the facilities at the National Disposal sites should not be considered.

## 7. REFERENCES

0295 Land, H.F., ed., Industrial pollution control handbook. New York, McGraw Hill Book Company, 1971.

0766 Sax, I.R., Dangerous properties of industrial materials. 3d ed. New York, Reinhold Publishing Corporation, 1968. 1,251 p.

1433 Kirk-Othmer encyclopedia of chemical technology. 3d ed. 22 v. New York, Interscience Publishers, 1966.

1501 Faith, W.L., D.B. Keyes and R.L. Clark. Industrial chemicals. 3d ed. New York, John Wiley and Sons, Inc. 1965. 824 p.

1506 Oil, paint and drug reporter profiles. New York, Schnell Publishing Company, Inc. 1970.

## HAZARDOUS WASTES PROPERTIES
## WORKSHEET

10

H. M. Name Acrylic Acid

IUC Name propenoic acid

Common Names acroleic acid

Structural Formula

$CH_2=CHCO_2H$

Molecular Wt. 72.06 Melting Pt. 14 C(1) Boiling Pt. 141 C(1)

Density (Condensed) 1.062(1) @ Density (gas) 2.5(1) @

Vapor Pressure (recommended 55 C and 20 C)

10 mm @ 39.0 C(1) @ @

Flash Point 130 F (O.C.)(1) Autoignition Temp.

Flammability Limits in Air (wt %) Lower Upper

Explosive Limits in Air (wt. %) Lower Upper

Solubility

Cold Water miscible(2) Hot Water Ethanol miscible(2)

Others: ether(2)

Acid, Base Properties

Highly Reactive with

Compatible with

Shipped in

ICC Classification Coast Guard Classification

Comments

References (1) 0766

(2) 1492

12

## HAZARDOUS WASTES PROPERTIES
## WORKSHEET

H. M. Name Adipic Acid

IUC Name 1,6-hexanedioic acid

Common Names 1,4-butane dicarboxylic acid

Structural Formula

$HO_2C(CH_2)_4CO_2H$

Molecular Wt. 146.14 Melting Pt. 152 C(1) Boiling Pt. 337.5 C(1)

Density (Condensed) 1.360 @ 25/4 C(1) Density (gas) 5.04(1) @

Vapor Pressure (recommended 55 C and 20 C)

1 mm @ 159.5 C(1) @ @

Flash Point 385 F (C.C.)(1) Autoignition Temp.

Flammability Limits in Air (wt %) Lower Upper

Explosive Limits in Air (wt. %) Lower Upper

Solubility

Cold Water Hot Water soluble(2) Ethanol soluble(2)

Others: methanol, acetone(2)

Acid, Base Properties

Highly Reactive with

Compatible with

Shipped in

ICC Classification Coast Guard Classification

Comments

References (1) 0766
(2) 1492

57

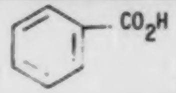
## HAZARDOUS WASTES PROPERTIES
## WORKSHEET

H. M. Name Benzoic Acid

IUC Name benzoic acid

Common Names

Structural Formula



Molecular Wt. 122.12 Melting Pt. 121.7 C(1) Boiling Pt. 249 C(1)

Density (Condensed) 1.316(1) @ Density (gas) 4.21(1) @

Vapor Pressure (recommended 55 C and 20 C)

1mm @ 96.0 C(1) @ @

Flash Point 250 F (C.C.)(1) Autoignition Temp. 1065 F(1)

Flammability Limits in Air (wt %) Lower Upper

Explosive Limits in Air (wt. %) Lower Upper

Solubility

Cold Water Hot Water Ethanol soluble(2)

Others: ether, acetone(2)

Acid, Base Properties

Highly Reactive with

Compatible with

Shipped in

ICC Classification Coast Guard Classification

Comments Sublimes at 96 C(1)

References (1) 0766
(2) 1492

## HAZARDOUS WASTES PROPERTIES
## WORKSHEET

197

H. M. Name Fatty Acids

IUC Name

Common Names

Structural Formula

$C_nH_{2n+1}CO_2H$

Molecular Wt.  Melting Pt.  Boiling Pt.

Density (Condensed) @  Density (gas) @

Vapor Pressure (recommended 55 C and 20 C)

@  @  @

Flash Point >150 C  Autoignition Temp. >100 F

Flammability Limits in Air (wt %)  Lower  Upper

Explosive Limits in Air (wt. %)  Lower  Upper

Solubility

Cold Water insoluble  Hot Water  Ethanol soluble

Others: many common organic solvents.

Acid, Base Properties

Highly Reactive with

Compatible with

Shipped in

ICC Classification  Coast Guard Classification

Comments A series of naturally occurring acids of more than eight carbon atoms usually found as esters.

References (1) 1433

## HAZARDOUS WASTES PROPERTIES WORKSHEET

202

H. M. Name Formic Acid

IUC Name methanoic acid

Common Names

Structural Formula

$HCO_2H$

Molecular Wt. 46.03 Melting Pt. 8.2 C(1) Boiling Pt. 100.8 C(1)

Density (Condensed) 1.2267 @ 15/14 C Density (gas) 1.59 @

Vapor Pressure (recommended 55 C and 20 C)

40 mm @ 24.0 C(1) @ @

Flash Point 156 F (O.C.)(1) Autoignition Temp. 1114 F(1)

Flammability Limits in Air (wt %) Lower Upper

Explosive Limits in Air (wt. %) Lower 18%(1). (90% solution) Upper 57%(1) (90% solution)

Solubility

Cold Water miscible(2) Hot Water Ethanol miscible(2)

Others: ether (2)

Acid, Base Properties

Highly Reactive with

Compatible with

Shipped in

ICC Classification Corrosive, white label(1) Coast Guard Classification whit- label(1)

Comments dangerously caustic to the skin.(2)

References (1) 0766
(2) 1492

**HAZARDOUS WASTES PROPERTIES
WORKSHEET**

356

H. M. Name Propionic Acid

IUC Name propanoic acid

Common Names

Structural Formula

$CH_3CH_2CO_2H$

Molecular Wt. 74.1 Melting Pt. -22 C(1) Boiling Pt. 141 C(1)

Density (Condensed) 0.992(1) @ Density (gas) 2.56 @

Vapor Pressure (recommended 55 C and 20 C)

10 mm @ 39.7 C(1) @ @

Flash Point 130 F(1) Autoignition Temp.

Flammability Limits in Air (wt %) Lower Upper

Explosive Limits in Air (wt. %) Lower Upper

Solubility

Cold Water miscible(2) Hot Water Ethanol soluble(2)

Others: ether, chloroform.(2)

Acid, Base Properties

Highly Reactive with

Compatible with

Shipped in

ICC Classification Coast Guard Classification

Comments Azeotrope with water, b.p. 99.98 C(1)

References (1) 0766
(2) 1492

366

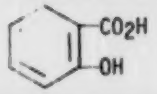
## HAZARDOUS WASTES PROPERTIES
## WORKSHEET

H. M. Name Salicylic Acid

IUC Name 2-hydroxybenzoic acid

Common Names

Structural Formula



Molecular Wt. 138.12 Melting Pt. 159 C(1) Boiling Pt.

Density (Condensed) 1.443 @ 20/4 C(1) Density (gas) 4.8(1) @

Vapor Pressure (recommended 55 C and 20 C)

1 mm @ 113.7 C(1) @ @

Flash Point 315 F(1) Autoignition Temp. 1013 F(1)

Flammability Limits in Air (wt %) Lower Upper

Explosive Limits in Air (wt. %) Lower Upper

Solubility

Cold Water Hot Water slightly soluble(2) Ethanol soluble(2)

Others: acetone, ether.(2)

Acid, Base Properties

Highly Reactive with

Compatible with

Shipped in

ICC Classification Coast Guard Classification

Comments Sublimes at 76 C.(1)

References (1) 0766
(2) 1492

# PROFILE REPORT ON
# ALCOHOLS

Allyl Alcohol (14), Amyl Alcohol (31), Butanols (70,74,490), Cyclohexanol (132), Decyl Alcohol (138), Diethylene Glycol (154), Dipropylene Glycol (168), Ethanol (172), Ethylene Glycol (186,206), Octyl Alcohol (191), Furfural Alcohol (204), Glycerine (205), Isopropanol (228), Methanol (261), Methyl Amyl Alcohol (266), *n*-Propyl Alcohol (358), Propylene Glycol (361), Sorbitol (407).

## 1. GENERAL

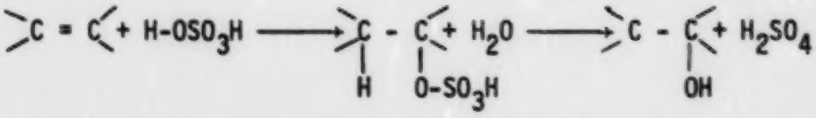
### Introduction

The alcohols treated in this report have all been selected as probable candidates for municipal disposal. These materials are similar in that most are commodity chemicals with relatively low toxicity, well-defined and safe methods of industrial handling and common methods of disposal. The alcohols are, therefore, discussed as a class in this report.

### Manufacture[1433,1506]

The alcohols treated in this report are manufactured by a wide variety of synthesis, some of which are specific to a given compound. The most important commercial wastes are discussed below.

Hydration of Alkenes. Alkenes can be hydrated in dilute sulfuric acid solution. The initial step is the addition of sulfuric acid across the double bond which is then hydrolized to the alcohol.



Ethanol as well as secondary and tertiary alcohols such as 2-propanol, 2-butanol, *t*-butanol and 2- and 3-pentanol (amyl alcohols) are manufactured in this way.

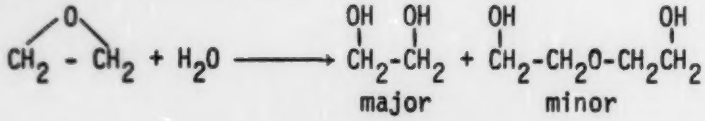
Reduction of Carbon Monoxide. The formation of methanol by the reaction of carbon monoxide with hydrogen at 250 to 400 C and 100 to 120 atm is a very important commercial process.

$$CO + 2H_2 \longrightarrow CH_3OH$$

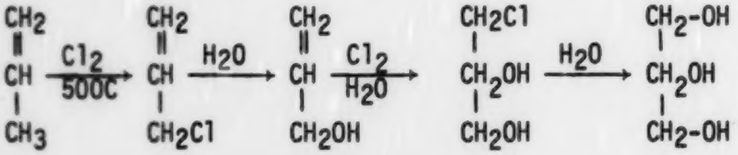
Hydrolysis of Organic Esters. The hydrolysis is catalyzed by both acids and bases. It is of considerable commercial importance for the production of alcohols from naturally occurring esters ($C_6$ and higher alcohols).

Reduction of Fatty Acids and Esters. The reduction of triglycerides, fatty acids or fatty acid esters by metallic sodium and a reducing alcohol or hydrogen in the presence of a specific catalyst is important in the manufacture of alcohols containing more than six carbon atoms. Sorbitol is manufactured from glucose in this manner.

Hydration of Alkylene Oxides. Ethylene and propylene glycol as well as their dimers are produced by the hydration of ethylene and propylene oxide. The dimeric alcohols diethylene glycol and dipropylene glycol are always produced as byproducts. The ratio of monomer to dimer decreases as the ratio of water to alkylene oxide decreases.



Glycerin or Glycerol is manufactured from propylene in the multi-step synthesis shown below. Approximately 60 percent of all glycerol is made this way, the remainder being produced from natural triglycerides.



The Oxo Process or Hydroformylation of the alkenes is important in the production of amyl alcohol, *n*-butanol, isobutanol,decyl alcohol, actyl alcohol (2-ethylhexanol), and others. In this process the alkene is hydroformylated with carbon monoxide and hydrogen in the presence of a cobalt catalyst at 160 to 175 C and 1,500 to 4,000 psi. The resulting aldehyde is then hydrogenated to the alcohol at 150 C and 400 atm with the presence of a nickel or copper chromate catalyst.

## Uses[1433,1492,1506]

Solvents and Chemical Intermediates. The major uses of alcohols are as solvents and chemical intermediates, especially in the production of esters and aldehydes. The esters are used in plasticizers, lubricants, soaps, perfumes, flavors, cosmetics, etc. Further details can be found in the Profile Report on Esters.

Antifreeze and Cosmetics. Glycerin and the glycols find wide use as antifreeze (especially ethylene glycol) and as special agents in soaps, perfumes and other cosmetics.

Food Additives. Sorbitol is used as a food fortifier, especially as a sugar substitute for diabetics.

## 2. TOXICOLOGY[0766]

With the exceptions of methanol and allyl alcohol which are discussed below, the alcohols treated in this report are relatively non-toxic. All are irritants to the mucous membranes, particularly the eyes, nose and respiratory passages. The higher alcohols are generally more toxic, but the danger is reduced due to their lack of volatility and low solubility in water. Ingestion causes headache, nausea, vomiting, delirium and other well-known symptoms generally classed as "hangover". Repeated exposure can cause damage to the kidneys, liver and blood vessels. These effects have not been investigated thoroughly for many of the alcohols. Glycerol, sorbitol, ethanol, octyl alcohol, decyl alcohol and propylene glycol present only slight danger. Allyl alcohol is a very strong irritant and requires much less to damage the liver and kidneys

Methanol, in addition to the effects discussed above, has a special toxic effect on the nervous system, particularly the optic nerves and possibly the retinae. Once absorbed, methanol is eliminated so slowly that it can be regarded as a cumulative poison. It is detoxified in the body by oxidation to formaldehyde and formic acid, both of which are toxic.

The Threshold Limit Values (TLV) and Maximum Allowable Concentrations (MAC) that have been established are as follows:

| Substance | TLV ppm | TLV mg/M$^3$ | MAC ppm |
|---|---|---|---|
| Allyl Alcohol | 2 | 5 | 2 |
| Amyl Alcohol | | | |
| Butanols | 100 | 300 | 100 |
| Cyclohexanol | 50 | 200 | |
| Decyl Alcohol | | | |
| Diethylene Glycol | | | |
| Dipropylene Glycol | | | |
| Ethanol | 1000 | 1900 | 1000 |
| Ethylene Glycol | | | 200 |
| Octyl Alcohol | | | |
| Furfural Alcohol | | | |
| Glycerin | | | |
| Isopropanol | 400 | 980 | |
| Methanol | 200 | 260 | 200 |
| Methyl Amyl Alcohol | 25 | 100 | |
| *n*-Propyl Alcohol | 200 | 500 | |
| Propylene Glycol | | | |
| Sorbitol | | | |

## 3. OTHER HAZARDS

No special hazards are connected with the handling of these compounds.[0766,1433]

## 4. DEFINITION OF WASTE MANAGEMENT PRACTICES

### Handling, Storage and Transportation

The alcohols treated in this report are all toxic to a certain extent due to the narcotic effects of high concentrations and irritating effects of the liquids or vapors, especially in the sensitive areas of the eyes, mucous membranes and respiratory tract. Thus, they should be handled in a well-ventilated area and protective clothing and respirators are recommended where necessary. In cases of accidental contact, all contaminated clothing should be removed and the skin washed thoroughly with soap and water.

These materials are shipped under a variety of U.S. Department of Transportation, Coast Guard and IATA regulations. Most regulations relate to the flammability of these compounds. Information on safe handling and use of these compounds can be found in standard reference sources or manufacturers' Technical Data Sheets.

## Disposal/Reuse

Manufacturers who use alcohols as chemical intermediates or process solvents recycle as much material as possible. Material used in perfumes, flavors, cosmetics, soaps, lubricants and antifreeze is consumed in small quantities by the public and is not recoverable. A substantial amount of the alcohols in this group is used to produce plasticizers, resins, paint lattices or plastics. This material is not recoverable.

Many of the various manufacturing processes result in dilute alcohol waste streams which have a high chemical and biological oxygen demand.[0285,1543] They can be treated on site or discharged into the municipal sewer.

Recommended air and water standards are listed below. The air standard is .01 TLV and the water standard is .01 TLV by weight in 2 liters of water in the absence of independent data. No standards have been recommended for compounds for which TLV's have not been established.

| Substance | Limit for Air (Man) | | Limit for Water (Man) | Limit for Water (Fish) |
|---|---|---|---|---|
| | ppm | mg/M$^3$ | ppm | ppm |
| Allyl Alcohol | 0.02 | 0.05 | 0.23 | 0.10 |
| Amyl Alcohol | | | | 30 |
| Butanols | 1.0 | 3.0 | 15 | 2.9 |
| Cyclohexanol | 0.5 | 2.0 | 10 | 0.01 - 1.0 |
| Decyl Alcohol | | | | |
| Diethylene Glycol | | | | 320 |
| Dipropylene Glycol | | | | 10 - 100 |
| Ethanol | 10 | 19 | 95 | 700 |
| Ethylene Glycol | 2.0 | | | 100 |
| Octyl Alcohol | | | | |
| Furfural Alcohol | | | | |
| Glycerin | | | | |
| Isorpopanol | 4.0 | 9.8 | 49 | 90 |
| Methanol | 2.0 | 2.6 | 13 | 25 |
| Methyl Amyl Alcohol | 0.25 | 1.0 | 5 | 1 - 10 |
| *n*-Propyl Alcohol | 2.0 | 5.0 | 25 | 30 |
| Propylene Glycol | | | | 10 - 100 |
| Sorbitol | | | | |

## 5. EVALUATION OF WASTE MANAGEMENT PRACTICES

### Option No.1 - Recycling

Manufacturers that use alcohols as chemical intermediates or process solvents recycle as much material as possible. In addition, a certain amount of contaminated alcohols are eligible for reprocessing. This is the method of choice wherever possible.

### Option No.2 - Treatment of Waste Water to Reduce Chemical and Biological Oxygen Demand

The alcohols treated in this report not only have a very low level of toxicity but they can be biodegraded very rapidly by unacclimated activated sludges. This is due in part to the fact that most are either naturally occurring or components present in normal sewage. Thus, the best method of disposal is via municipal sewage treatment plants, provided the rate of discharge is uniform.

### Option No.3 - Incineration

Bulk quantities of contaminated alcohols that can not be reprocessed or released by controlled dilution can best be disposed of by incineration. Since this will probably be an unusual occurrence, this is best done at municipal incineration sites.

## 6. APPLICABILITY TO NATIONAL DISPOSAL SITES

All of the wastes generated by the industries that produce and use the alcohols treated in this report can be handled by municipal disposal either by sewage treatment or incineration. Disposal is so easy and safe that use of facilities at the National Disposal Sites should not be considered.

## 7. REFERENCES

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1492 Merck index of chemicals and drugs. 7th ed. Rahway, New Jersey, Merck Company, Inc., 1960. 1,634 p.

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1543 Luzack, F.J. and M.B. Ettinger, *Journal Water Pollution Control Federation*, 32:1173-1200, 1960.

HAZARDOUS WASTES PROPERTIES
WORKSHEET

14

H. M. Name Allyl Alcohol

IUC Name 2-propene-1-ol

Common Names

Structural Formula

$CH_2=CH-CH_2OH$

Molecular Wt. 58.08 Melting Pt. -129 C(1) -50 C(2) Boiling Pt. 96-97 C(1)

Density (Condensed) .8540 @ 20/4 C(1) Density (gas) 2.00(1) @

Vapor Pressure (recommended 55 C and 20 C)

10 mm @ 10.5 C(1) @ @

Flash Point 70 F (O.C.)(1) Autoignition Temp. 713 F(1)

Flammability Limits in Air (wt %) Lower Upper

Explosive Limits in Air (wt. %) Lower 2.5%(1) Upper 18%(1)

Solubility

Cold Water miscible(2) Hot Water miscible(2) Ethanol miscible(2)

Others: miscible chloroform, ether, petroleum ether(2)

Acid, Base Properties

Highly Reactive with

Compatible with

Shipped in

ICC Classification Coast Guard Classification

Comments Polymerizes slowly on storage to a thick syrup.(2)

References (1) 0766
(2) 1492

## HAZARDOUS WASTES PROPERTIES
## WORKSHEET

31-A

H. M. Name Amyl Alcohol

IUC Name 1-pentanol

Common Names pentyl alcohol, n-amyl alcohol, n-butyl carbinol

Structural Formula

$CH_3$-$CH_2$-$CH_2$-$CH_2$-$CH_2$-OH

Molecular Wt. 88.15 Melting Pt. -79 C(1) Boiling Pt. 138.1 C(1)

Density (Condensed) 0.824 @ 20/20 C(1) Density (gas) 3.04(1) @

Vapor Pressure (recommended 55 C and 20 C)

1 mm @ 13.6 C(1) 10 mm @ 44.9 C(1) @

Flash Point 100 F (C.C.)(2) Autoignition Temp. 572 F(1)

Flammability Limits in Air (wt %) Lower Upper

Explosive Limits in Air (wt. %) Lower 1.2%(1) Upper 10% at 100 C(1)

Solubility

Cold Water 2.7 g/100 ml at 22 C(2) Hot Water Ethanol miscible(2)

Others:

Acid, Base Properties

Highly Reactive with

Compatible with

Shipped in

ICC Classification Coast Guard Classification Combustible liquid

Comments There are three amyl alcohols: 1, 2 and 3-pentanol. All have similar properties.

References (1) 0766
(2) 1492

## HAZARDOUS WASTES PROPERTIES WORKSHEET

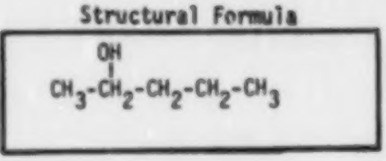
31-B

H. M. Name Amyl Alcohol

IUC Name 2-pentanol

Common Names dl-sec-amyl alcohol, methyl propyl carbinol

Structural Formula



$CH_3-\overset{OH}{\overset{|}{CH_2}}-CH_2-CH_2-CH_3$

Molecular Wt. 88.15 Melting Pt. -50 C(1) Boiling Pt. 119.3 C(1)

Density (Condensed) 0.811 @ 20/20 C(2) Density (gas) 3.04(1) @

Vapor Pressure (recommended 55 C and 20 C)

@ @ @

Flash Point 105 F (O.C.)(2) Autoignition Temp. 650 F to 725 F(1)

Flammability Limits in Air (wt %) Lower Upper

Explosive Limits in Air (wt. %) Lower Upper 9.0%(1)

Solubility

Cold Water 16.6 g/100 ml at 20 C(2) Hot Water Ethanol miscible(2)

Others: miscible ether(2)

Acid, Base Properties

Highly Reactive with

Compatible with

Shipped in

ICC Classification Coast Guard Classification

Comments

References (1) 0766
(2) 1492

## HAZARDOUS WASTES PROPERTIES WORKSHEET

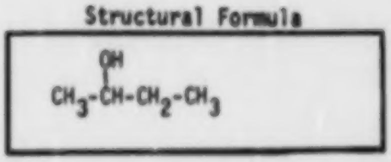
70,74,490-B

H. M. Name Butanols

IUC Name 2-butanol

Common Names methyl alkyl carbinol, sec-butyl alcohol

Structural Formula



$CH_3-\overset{\overset{OH}{|}}{C}H-CH_2-CH_3$

Molecular Wt. 74.12 Melting Pt. -89 C(1) Boiling Pt. 99.5 C(1)

Density (Condensed) 0.808 @ 20/4 C(1) Density (gas) 2.55(1) @

Vapor Pressure (recommended 55 C and 20 C)

10 mm @ 20 C(1) @ @

Flash Point 75 F (C.C.)(1) Autoignition Temp. 763 F(1)

Flammability Limits in Air (wt %) Lower Upper

Explosive Limits in Air (wt. %) Lower 1.7% at 100 C(2) Upper 9.8% at 100 C(1)

Solubility

Cold Water 10 wt.%(2) Hot Water Ethanol miscible(2)

Others: miscible ether and other organic colvents.(2)

Acid, Base Properties

Highly Reactive with

Compatible with

Shipped in

ICC Classification Coast Guard Classification

Comments MCA warning label.

References (1) 0766
(2) 1492

## HAZARDOUS WASTES PROPERTIES WORKSHEET

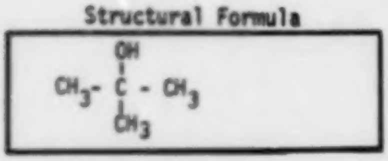
70,44,490-C

H. M. Name Butanols

IUC Name 2-methyl-2-propanol

Common Names trimethylcarbinol, *tert*-butanol

Structural Formula



$$CH_3-\overset{\displaystyle OH}{\underset{\displaystyle CH_3}{C}}-CH_3$$

Molecular Wt. 74.12 Melting Pt. 25.3 C[(1)] Boiling Pt. 82.41 C[(1)]

Density (Condensed) 0.7887 @ 20/4 C[(1)] Density (gas) 2.55[(1)] @

Vapor Pressure (recommended 55 C and 20 C)

40 mm @ 24.5 C[(1)] @ @

Flash.Point 52 F (C.C.)[(1)] Autoignition Temp. 892 F[(1)]

Flammability Limits in Air (wt %) Lower Upper

Explosive Limits in Air (wt. %) Lower 2.4%[(1)] Upper 8.0%[(1)]

Solubility

Cold Water soluble[(2)] Hot Water Ethanol miscible[(2)]

Others: miscible ether[(2)]

Acid, Base Properties

Highly Reactive with

Compatible with

Shipped in

ICC Classification Coast Guard Classification

Comments MCA warning label

References (1) 0766
(2) 1492

## HAZARDOUS WASTES PROPERTIES
## WORKSHEET

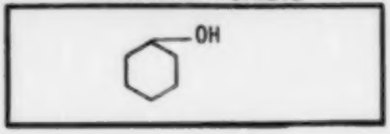
132

H. M. Name Cyclohexanol

IUC Name cyclohexanol

Common Names hexahydrophenol

Structural Formula



Molecular Wt. 100.16 Melting Pt. -9 C(1) Boiling Pt. 161.5 C(1)

Density (Condensed) 0.9449 @ 25/4 C(1) Density (gas) 3.45 C(1) @

Vapor Pressure (recommended 55 C and 20 C)

1 mm @ 21.0 C(1) @ @

Flash Point 154 F (C.C.)(1) Autoignition Temp. 572 F(1)

Flammability Limits in Air (wt %) Lower Upper

Explosive Limits in Air (wt. %) Lower Upper

**Solubility**

Cold Water 3.6 wt.% at 20 C(2) Hot Water Ethanol miscible(2)

Others: miscible ethyl acetate, linseed oil, petroleum solvents.(2)

Acid, Base Properties

Highly Reactive with

Compatible with

Shipped in

ICC Classification Coast Guard Classification

Comments

References (1) 0766

(2) 1492

## HAZARDOUS WASTES PROPERTIES WORKSHEET

138

H. M. Name Decyl Alcohol

IUC Name 1-decanol

Common Names n-decyl alcohol, nonyl carbinol

Structural Formula

$CH_3$-$(CH_2)_8$-$CH_2OH$

Molecular Wt. 158.3 Melting Pt. 7 C(1) Boiling Pt. 231.0 C(1)

Density (Condensed) 0.8297 @ 20/4 C(1) Density (gas) 5.3(1) @

Vapor Pressure (recommended 55 C and 20 C)

1 mm @ 69.5 C(1) @ @

Flash Point 180 F(1) Autoignition Temp.

Flammability Limits in Air (wt %) Lower Upper

Explosive Limits in Air (wt. %) Lower Upper

**Solubility**

Cold Water Hot Water Ethanol soluble

Others:

Acid, Base Properties

Highly Reactive with

Compatible with

Shipped in

ICC Classification Coast Guard Classification

Comments

References (1) 0766

# HAZARDOUS WASTES PROPERTIES
# WORKSHEET

154

H. M. Name Diethylene Glycol

IUC Name

Common Names diglycol

Structural Formula

$HO-CH_2-CH_2-O-CH_2CH_2-OH$

Molecular Wt. 106.12 Freezing Pt. -8 C(1) Boiling Pt. 245.8 C(1)

Density (Condensed) 1.1184 @ 20/20 C(1) Density (gas) 3.66(1) @

Vapor Pressure (recommended 55 C and 20 C)

1 mm @ 91.8 C(1) @ @

Flash Point 255 F(1) Autoignition Temp. 444 F(1)

Flammability Limits in Air (wt %) Lower Upper

Explosive Limits in Air (wt. %) Lower Upper

Solubility

Cold Water miscible(2) Hot Water miscible(2) Ethanol miscible(2)

Others: miscible ether, acetone,(2) insoluble benzene and its homologues, chlorinated hydrocarbons.(2)

Acid, Base Properties

Highly Reactive with

Compatible with

Shipped in

ICC Classification Coast Guard Classification

Comments

References (1) 0766
(2) 1492

# HAZARDOUS WASTES PROPERTIES WORKSHEET

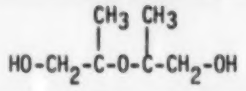
168

H. M. Name Dipropylene Glycol

IUC Name 2,2'-dihydroxyisopropyl ether

Common Names

Structural Formula



$HO-CH_2-\overset{CH_3}{\overset{|}{C}}-O-\overset{CH_3}{\overset{|}{C}}-CH_2-OH$

Molecular Wt. 134.17 Melting Pt. Boiling Pt. 231.8 C(1)

Density (Condensed) 1.0252 @20/20 C(1) Density (gas) 4.63(1) @

Vapor Pressure (recommended 55 C and 20 C)

1 mm @ 73.8 C(1) @ @

Flash Point 280 F (O.C.)(1) Autoignition Temp.

Flammability Limits in Air (wt %) Lower Upper

Explosive Limits in Air (wt. %) Lower Upper

Solubility

Cold Water soluble Hot Water Ethanol soluble

Others:

Acid, Base Properties neutral

Highly Reactive with

Compatible with

Shipped in

ICC Classification Coast Guard Classification

Comments

References (1) 0766

## HAZARDOUS WASTES PROPERTIES WORKSHEET

172

H. M. Name Ethanol

IUC Name

Common Names methyl carbinol, ethyl alcohol

Structural Formula

$CH_3$-$CH_2$-OH

Molecular Wt. 46.07 Freezing Pt. -114.1 C(1) Boiling Pt. 78.32 C(1)

Density (Condensed) 0.7893 @ 20/4 C(1) Density (gas) 1.59(1) @

Vapor Pressure (recommended 55 C and 20 C)

40 mm @ 19 C(1) @ @

Flash Point 55 F(1) Autoignition Temp. 793 F(1)

Flammability Limits in Air (wt %) Lower Upper

Explosive Limits in Air (wt. %) Lower 4.3%(1) Upper 19%(1)

Solubility

Cold Water miscible(2) Hot Water miscible(2) Ethanol

Others: miscible acetone, ether, chloroform.(2)

Acid, Base Properties

Highly Reactive with

Compatible with

Shipped in

ICC Classification Coast Guard Classification

Comments

References (1) 0766
(2) 1492

## HAZARDOUS WASTES PROPERTIES
## WORKSHEET

186,206

H. M. Name Ethylene Glycol

IUC Name 1,2-ethanediol

Common Names glycol, glycol alcohol

Structural Formula

HO-$CH_2CH_2$-OH

Molecular Wt. 102.1 Freezing Pt. -13 C(1) Boiling Pt. 197.5 C(1)

Density (Condensed) 1.113 @25/25 C(1) Density (gas) 2.14(1) @

Vapor Pressure (recommended 55 C and 20 C)

0.05 mm @20 C(1) @ @

Flash Point 232 F (C.C.)(1) Autoignition Temp. 775 F(1)

Flammability Limits in Air (wt %) Lower Upper

Explosive Limits in Air (wt. %) Lower 3.2% Upper

Solubility

Cold Water miscible(2) Hot Water miscible(2) Ethanol miscible(2)

Others: soluble lower alcohols, acetic acid, acetone, pyridine(2)
insoluble benzene and its homologues, chlorinated hydrocarbons(2)

Acid, Base Properties

Highly Reactive with

Compatible with

Shipped in

ICC Classification Coast Guard Classification

Comments very hydroscopic(2)

References (1) 0766
(2) 1492

## HAZARDOUS WASTES PROPERTIES
## WORKSHEET

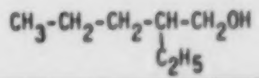
191

H. M. Name Octyl Alcohol

IUC Name 2-ethyl-1-hexanol

Common Names 2-ethylhexyl alcohol

Structural Formula



$$\begin{array}{l}CH_3\text{-}CH_2\text{-}CH_2\text{-}\underset{\displaystyle C_2H_5}{\underset{|}{CH}}\text{-}CH_2OH\end{array}$$

Molecular Wt. 130.23 Melting Pt. <-76 C(1) Boiling Pt. 179-185.5 C(1)

Density (Condensed) 0.834 @ 20/20 C(1) Density (gas) 4.49(1) @

Vapor Pressure (recommended 55 C and 20 C)

0.2 mm @ 20 C(1) @ @

Flash Point 178 F(1) Autoignition Temp.

Flammability Limits in Air (wt %) Lower Upper

Explosive Limits in Air (wt. %) Lower Upper

Solubility

Cold Water 0.1 ml/100 ml(2) Hot Water Ethanol miscible(2)

Others: miscible ether(2)

Acid, Base Properties

Highly Reactive with

Compatible with

Shipped in

ICC Classification Coast Guard Classification

Comments

References (1) 0766
(2) 1492

## HAZARDOUS WASTES PROPERTIES
## WORKSHEET

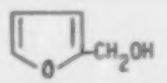
204

H. W. Name Furfuryl Alcohol

IUC Name

Common Names 2-furyl alcohol

Structural Formula



Molecular Wt. 98.1 Melting Pt. -31 C(1) Boiling Pt. 171 C(750mm)(1)

Density (Condensed) 1.129 @ 20/4 C(1) Density (gas) 3.37(1) @

Vapor Pressure (recommended 55 C and 20 C)

1 mm @ 31.8 C(1) @ @

Flash Point 167 F (O.C.)(1) Autoignition Temp. 915 F(1)

Flammability Limits in Air (wt %) Lower Upper

Explosive Limits in Air (wt. %) Lower 1.8% (72-122 C)(1) Upper 16.3% (72-122 C)(1)

Solubility

Cold Water miscible(2) Hot Water Ethanol miscible(2)

Others:

Acid, Base Properties easily resinified by acids.(2)

Highly Reactive with

Compatible with

Shipped in

ICC Classification Coast Guard Classification

Comments unstable in water.(2)

References (1) 0766

(2) 1492

## HAZARDOUS WASTES PROPERTIES WORKSHEET

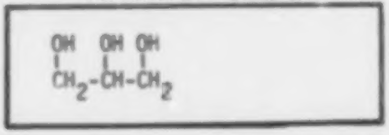
205

H. M. Name Glycerin

IUC Name 1,2,3-propanetriol

Common Names glycerol

Structural Formula



$\overset{\overset{OH}{|}}{CH_2}-\overset{\overset{OH}{|}}{CH}-\overset{\overset{OH}{|}}{CH_2}$

Molecular Wt. 92.09 Melting Pt. 17.9 C(1) Boiling Pt. 290 C(1)

Density (Condensed) 1.260 @ 20/4 C(1) Density (gas) 3.17(1) @

Vapor Pressure (recommended 55 C and 20 C)

0.0025 mm @ 50 C(1) @ @

Flash Point 320 F(1) Autoignition Temp. 739 F(1)

Flammability Limits in Air (wt %) Lower Upper

Explosive Limits in Air (wt. %) Lower Upper

Solubility

Cold Water miscible(2) Hot Water miscible(2) Ethanol miscible(2)

Others: soluble ethyl acetate, ether;(2) insoluble benzene, chloroform, petroleum solvents.(2)

Acid, Base Properties neutral

Highly Reactive with

Compatible with

Shipped in

ICC Classification Coast Guard Classification

Comments absorbs water, $H_2S$, HCN, and $SO_2$ readily.(2)

References (1) 0766
(2) 1492

HAZARDOUS WASTES PROPERTIES
WORKSHEET

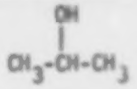
228

H. M. Name Isopropanol

IUC Name 2-propanol

Common Names isopropyl alcohol

Structural Formula



$$CH_3-\overset{\overset{OH}{|}}{CH}-CH_3$$

Molecular Wt. 60.09 Melting Pt. -88.5 C(1) Boiling Pt. 82.3 C(1)

Density (Condensed) 0.7854 @ 20/4 C(1) Density (gas) 2.07(1) @

Vapor Pressure (recommended 55 C and 20 C)

33.0 mm @ 20 C(1) @ @

Flash Point 53 F(1) Autoignition Temp. 750 F(1)

Flammability Limits in Air (wt %) Lower Upper

Explosive Limits in Air (wt. %) Lower 2.0%(1) Upper 12%(1)

Solubility

Cold Water miscible(2) Hot Water miscible(2) Ethanol miscible(2)

Others: soluble ether, chloroform.(2)

Acid, Base Properties neutral

Highly Reactive with

Compatible with

Shipped in

ICC Classification Coast Guard Classification

Comments

References (1) 0766
(2) 1492

## HAZARDOUS WASTES PROPERTIES WORKSHEET

261

H. M. Name Methanol

IUC Name

Common Names methyl alcohol

Structural Formula

$CH_3OH$

Molecular Wt. 32.04 Freezing Pt. -97.8 C(1) Boiling Pt. 64.8 C(1)

Density (Condensed) 0.7913 @ 20/4 C(1) Density (gas) 1.11(1) @

Vapor Pressure (recommended 55 C and 20 C)

100 mm @ 21.2 C(1) @ @

Flash Point 52 F(1) Autoignition Temp. 867 F(1)

Flammability Limits in Air (wt %) Lower Upper

Explosive Limits in Air (wt. %) Lower 7.3%(1) Upper 36.5%(1)

Solubility

Cold Water miscible(2) Hot Water miscible(2) Ethanol miscible(2)

Others: miscible ether, benzene and most organic solvents.(2)

Acid, Base Properties

Highly Reactive with

Compatible with

Shipped in

ICC Classification Coast Guard Classification

Comments

References (1) 0766
(2) 1492

HAZARDOUS WASTES PROPERTIES
WORKSHEET

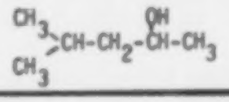
266

H. M. Name Methyl Amyl Alcohol

IUC Name 4-methyl-2-pentanol

Common Names methyl isobutyl carbinol

Structural Formula



$(CH_3)_2CH-CH_2-CH(OH)-CH_3$

Molecular Wt. 102.2 Freezing Pt. <-90 C(1) Boiling Pt. 131.8 C(1)

Density (Condensed) 0.8079 @ 20/20 C(1) Density (gas) 3.53(1) @

Vapor Pressure (recommended 55 C and 20 C)

2.8 mm @ 20 C(1) @ @

Flash Point 106 F(1) Autoignition Temp.

Flammability Limits in Air (wt %) Lower Upper

Explosive Limits in Air (wt. %) Lower 1.0%(1) Upper 5.5%(1)

Solubility

Cold Water insoluble Hot Water Ethanol soluble

Others:

Acid, Base Properties

Highly Reactive with

Compatible with

Shipped in

ICC Classification Coast Guard Classification

Comments

References (1) 0766

## HAZARDOUS WASTES PROPERTIES
## WORKSHEET

358

H. M. Name n-Propyl Alcohol

IUC Name 1-propanol

Common Names ethyl carbinol

Structural Formula

$CH_3-CH_2-CH_2OH$

Molecular Wt. 60.1 Melting Pt. -127 C(1) Boiling Pt. 97.19 C(1)

Density (Condensed) 0.8044 @ 20/4 C(1) Density (gas) 2.07(1) @

Vapor Pressure (recommended 55 C and 20 C)

10 mm @ 14.7 C(1) @ @

Flash Point 59 C (C.C.)(1) Autoignition Temp. 700 F(1)

Flammability Limits in Air (wt %) Lower Upper

Explosive Limits in Air (wt. %) Lower 2.1%(1) Upper 13.5%(1)

Solubility

Cold Water miscible(2) Hot Water miscible(2) Ethanol miscible(2)

Others: miscible ether(2)

Acid, Base Properties

Highly Reactive with

Compatible with

Shipped in

ICC Classification Coast Guard Classification

Comments

References (1) 0766
(2) 1492

## HAZARDOUS WASTES PROPERTIES WORKSHEET

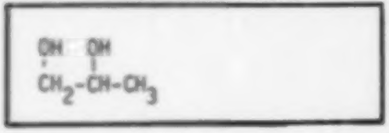
361

H. M. Name Propylene Glycol

IUC Name 1,2-propanediol

Common Names

Structural Formula



$$\overset{OH}{CH_2}-\overset{OH}{CH}-CH_3$$

Molecular Wt. 76.1 Melting Pt. Boiling Pt. 188.2 C(1)

Density (Condensed) 1.0362 @ 25/25 C(1) Density (gas) 2.62(1) @

Vapor Pressure (recommended 55 C and 20 C)

0.08 mm @ 20 C(1) @ @

Flash Point 210 F(O.C.)(1) Autoignition Temp. 790 F(1)

Flammability Limits in Air (wt %) Lower Upper

Explosive Limits in Air (wt. %) Lower 2.6%(1) Upper 12.6%(1)

**Solubility**

Cold Water miscible(2) Hot Water miscible(2) Ethanol miscible(2)

Others: miscible acetone, chloroform(2)

Acid, Base Properties

Highly Reactive with

Compatible with

Shipped in

ICC Classification Coast Guard Classification

Comments hydroscopic liquid.

References (1) 0766

(2) 1492

407

## HAZARDOUS WASTES PROPERTIES
## WORKSHEET

H. M. Name Sorbitol

IUC Name

Common Names

Structural Formula

$HOCH_2-(CH_2OH)_4-CH_2OH$

Molecular Wt. 182.  Melting Pt. 97.5 C(1)  Boiling Pt. dec.(1)

Density (Condensed) 1.47 @ -5 C(1)  Density (gas) @

Vapor Pressure (recommended 55 C and 20 C)

@  @  @

Flash Point  Autoignition Temp.

Flammability Limits in Air (wt %)  Lower  Upper

Explosive Limits in Air (wt. %)  Lower  Upper

Solubility

Cold Water 83 wt.%(2)  Hot Water  Ethanol soluble hot(2)

Others: soluble alcohols, phenol, acetone, DMF, pyridine.(2)

Acid, Base Properties $K_a$(17.5 C) = $2.5 \times 10^{-14}$, aqueous pH 7.0

Highly Reactive with

Compatible with

Shipped in

ICC Classification  Coast Guard Classification

Comments

References (1) 0766
(2) 1492

# PROFILE REPORT

## Ammonium Hydroxide (19), Boron Chloride (62), Carbon Disulfide (98), Carbon Monoxide (99), Hydrochloric Acid (aq) (214), Hydrofluoric Acid (aq) (216), Hydrogen Chloride (g) (217), Hydrogen Peroxide (aq., >52%) (219), Iodine (tincture) (233), Mixed Acids (277), Nitric Acid (299), Nitrous Oxide (313), Silicon Tetrachloride (369), Sulfur Dioxide (414), Sulfuric Acid (415), Sulfurous Acid (416), Sulfuryl Fluoride (417), Sulfur Trioxide (509)

## 1. GENERAL

### Introduction

The inorganic chemicals discussed in this Profile Report have been preliminarily identified as probable candidates for industrial disposal. The grouping is based on broad chemical and/or physical similarities and covers both gases and liquids.

### Manufacture and Uses

The industrial processes of manufacturing and uses of the materials in this report are summarized briefly as follows.

Ammonium Hydroxide. Ammonium hydroxide, $NH_4OH$, also called ammonia water, is essentially ammonia dissolved in water. Ammonia is a very important and basic raw material for modern chemical industry. It is produced in large tonnage by the well-known Haber process in which hydrogen and nitrogen gases react catalytically under elevated temperature and pressure to yield ammonia. In 1965, 8.4 million tons of ammonia were produced in the United States.[1662] The weaker ammonia water (10%) has been used as a reflex stimulant. The stronger ammonia water (28-29%) may be used for the following purposes:[1492]

(1) as a detergent and in removing stains, bleaching, calico printing, and extracting plant colors (cochineal, archil, etc.) and alkaloids;

(2) in the manufacture of ammonium salts, aniline dyes;

(3) as a chemical reagent and in a wide variety of other uses.

Boron Chloride.[1433] Boron chloride, $BCl_3$, is a colorless gas produced commerically by chlorination of a mixture of boron trioxide and carbon at a temperature range of 1600 to 1800 F. It can also be prepared according to the reactions shown below:

(1) $7B_2O_3 + 6NaCl \xrightarrow{\text{800 to 1000 C}} 2BCl_3 + 3Na_2B_4O_7$

(2) $2NaBF_4 + 3MgCl_2 \xrightarrow{\text{500 to 1000 C}} 2BCl_3 + 2NaF + 3MgF_2$

(3) $2B_2O_3 + 3SiCl_3 \xrightarrow{\text{600 to 1000 C}} 4BCl_3 + 3SiO_2$

Its uses are:

(1) in the manufacture of other boron compounds;

(2) as an acidic catalyst for organic reactions;

(3) in the purification of aluminum, magnesium, zinc and copper alloys to remove nitrides, carbides, and oxides.

Carbon Disulfide.[1433] Carbon disulfide, $CS_2$, is a colorless and extremely volatile and flammable liquid. It is produced by:

(1) the long-used electrothermal charcoal-sulfur process;

$$C + 2S \xrightarrow{\text{750 to 1000 C}} CS_2$$

(2) the catalytic hydrocarbon-sulfur process;

$$CH_4 + 4S \longrightarrow CS_2 + 2H_2S$$

$$C_3H_8 + 10S \longrightarrow 3CS_2 + 4H_2S$$

In 1964, 669 million lb of carbon disulfide were produced in the United States.[1662] Its uses are:

(1) in the manufacture of regenerated cellulose (about 62 to 65 percent of carbon disulfide used for this purpose);

(2) in the manufacture of carbon tetrachloride (about 15 percent for this purpose);

(3) as a solvent;

(4) in the rubber industry.

Carbon Monoxide.[1492] Carbon Monoxide, CO, is a colorless and odorless gas, highly poisonous and flammable. It is produced by partial oxidation of hydrocarbon gases from the natural gas or by the gasification of coal or coke. Its uses are:

(1) as a reducing agent in various metallurgical processes;

(2) in organic synthesis, especially in the Fischer-Tropsh process;

(3) in the manufacture of acids, esters, hydroxy acids, and metal carbonyls;

(4) in the preparation of some catalysts.

Hydrochloric Acid. Hydrogen chloride, HCl (g), is a colorless gas. Its aqueous solution is the hydrochloric acid. It is produced from four major processes:[1662]

(1) as a by-product in the chlorination of both the aromatic and aliphatic hydrocarbons;

(2) from the reaction between sulfuric acid and salts of hydrochloric acid such as the common salt, NaCl;

(3) from the combustion of hydrogen and chlorine;

(4) from the Hargreaves type reactions such as

$$4NaCl + 2SO_2 + O_2 + 2H_2O \longrightarrow 2Na_2SO_4 + 4HCl$$

In 1969, 1.8 million tons were produced in the United States. Its major uses are:[1492]

(1) in the manufacture of pharmaceutical hydrochlorides, various inorganic and organic chlorides, and chlorine;

(2) in chlorination, isomerization, polymerization and alkylation processes;

(3) as a chemical reagent.

Hydrofluoric Acid.[1433] Hydrofluoric acid, HF, is a colorless, fuming, corrosive liquid or gas. It is produced in heated kilns by reacting fluorspar, $CaF_2$, with sulfuric acid.

$$CaF_2 + H_2SO_4 \xrightarrow{200 \text{ to } 250 \text{ C}} CaSO_4 + 2HF$$

The U.S. production of hydrofluoric acid amounted to about 310,000 tons in 1969. Its uses are:

(1) in the manufacture of fluorinated organics;

(2) in the manufacture of synthetic cryolite, fluorides, fluoborates, fluorosilicon products;

(3) in producing nuclear energy feed materials;

(4) in petroleum industry as an alkylation catalyst;

(5) in stainless steel industry;

(6) in etching and polishing glasses.

Hydrogen Peroxide.[1433, 1492] Hydrogen peroxide, $H_2O_2$, is a colorless, heavy liquid or at low temperatures a crystalline solid. It is manufactured by:

(1) autoxidation of anthraquinone;

(2) oxidation of a lower secondary alcohol, preferably isopropyl alcohol, to yield $H_2O_2$ and ketone;

(3) electrolysis through ammonium persulfate.

In 1969, 70,000 tons of $H_2O_2$ were produced in the United States. Its uses are:

(1) as a bleaching agent of cotton textiles (largest uses);

(2) as an oxidizing agent for organic compounds (second largest application);

(3) as an oxidizing agent for inorganic compounds;

(4) in the manufacture of organic and inorganic peroxides;

(5) in the plastics industry;

(6) in pharmaceutical preparations, mouth washes, dentifrices, sanitary lotions;

(7) as a topical antiseptic;

(8) in rocket propulsion (using 90 percent solution).

Iodine (tincture).[1433, 1662] Iodine is a violet-black rhombic crystal with metallic luster. It is soluble in water and organic solvents such as alcohol, ether, etc. It is produced by extraction from (1) the nitrate-bearing earth known as caliche in Chile, (2) brine, and (3) seaweed. The U.S. consumption of iodine amounts to about 3,500 tons a year. Its main uses are:

(1) in the production of potassium iodide for photography (about 38 percent of total iodine is for this purpose);

(2) in the manufacture of other iodine compounds, germicides, antiseptics;

(3) as a catalyst in alkylation and condensation of aromatic amines, sulfations, and sulfonations;

(4) as an additive to salt to meet the requirements of the thyroid gland;

(5) as an analytical reagent;

(6) in various nutritional, medicinal and sanitary applications;

(7) in making artifical isotopes for biochemical, biological and chemical structure research.

Mixed Acids.[1433] Mixed acids are mixtures of sulfuric acid and nitric acid in various proportions. The standard mixed acid contains 36 percent of concentrated nitric acid and 61 percent of concentrated sulfuric acid. It is mainly used for nitrating purposes such as in producing the nitrated cotton. The presence of concentrated sulfuric acid increases the efficiency of the nitration by absorbing the water which is the product of nitration reaction.

Nitric Acid.[1433] Nitric acid, $HNO_3$, is a colorless or yellowish, fuming suffocating, corrosive liquid. Virtually all nitric acid produced commercially is obtained by the ammonia oxidation process. Despite the many variations in the manufacturing details, the basic steps are as follows:

(1) Oxidation of ammonia to nitric oxide;

$$4NH_3 + 5O_2 \longrightarrow 4NO + 6H_2O$$

(2) Oxidation of nitric oxide to dioxide;

$$2NO + O_2 \longrightarrow 2NO_2$$

(3) Absorption of nitrogen dioxide in water to yield nitric acid and release additional nitric oxide;

$$3NO_2 + H_2O \longrightarrow 2HNO_3 + NO$$

In 1969, the total U.S. production of nitric acid was about 6.14 million tons. Its main uses are summarized as follows:

(1) About 70 to 85 percent of nitric acid produced is used to produce ammonium nitrate which is used as fertilizer;

(2) About another 5 to 10 percent is used to produce cyclohexanone which is the raw material for making the monomers for nylon;

(3) The remaining nitric acid is used for manufacturing various inorganic and organic nitrates and nitro compounds.

Nitrous Oxide.[1433, 1492] Nitrous oxide, $N_2O$, more commonly known as laughing gas, is a colorless gas with a slight sweet odor and taste. It is prepared by thermal decomposition of ammonium nitrate at a temperature range of 170 to 260 C. It can also be prepared by reaction between hydroxylamine ($NH_2OH$) and nitrous acid ($HNO_2$). Its uses are:

(1) as inhalation anesthetic and analgesic;

(2) as an oxidizing agent for organic compounds;

(3) in the manufacture of nitriles;

(4) in rocket fuel formulation;

(5) in the preparation of whipped cream.

Silicon Tetrachloride.[1433] Silicon tetrachloride, $SiCl_4$, is a colorless, fuming liquid with a suffocating odor. It is decomposed by water into silicic and hydrochloric acids with much heat liberated. Commercially, it is produced by reacting silicon carbide with chlorine gas. The production in the United States is about 35 to 40 million lb a year. Its main uses are:

(1) in producing smoke screen (fumed silica) in warfare;

(2) in the manufacture of high purity silicon;

(3) in the synthesis of silicon esters;

(4) in making special glass for the electronic industry.

Sulfur Dioxide.[1433] Sulfur dioxide, $SO_2$, is a colorless gas with a strong pungent, suffocating odor. It is mainly produced by the oxidation of sulfur, and also an undesirable by-product in the exhaust streams of petroleum refining, natural gas processing and coal-burning power plants. About 85 percent of $SO_2$ produced goes into manufacturing sulfuric acid. The other uses are:

(1) in the manufacture of pulp and paper;

(2) as a bleaching agent, refrigerant, and liquid solvent;

(3) in the manufacture of other chemicals;

(4) in preserving fruits, vegetables, etc., and as a disinfectant in breweries and food factories.[1492]

Sulfuric Acid.[1662] Sulfuric acid, $H_2SO_4$, is a colorless, oily, corrosive liquid. It is so widely used that it may be considered as the foundation of the modern chemical and petrochemical industries. In 1969, 28 million tons were produced in the United States. Its main uses are given as follows:

(1) 44 percent of the sulfuric acid produced in the United States is used to manufacture superphosphate (36%) and phosphate-type (8%) fertilizers;

(2) 21 percent is used in the chemical industry for making phosphoric acid, aluminum sulfate, paper, etc.;

(3) 10 percent is used in the petroleum industry, mainly in the alkylation process (55%);

(4) Other major uses are in the manufacture of titanium pigments, steel pickling, rayon, dyes and intermediates, detergents, etc.

Sulfurous Acid.[1433, 1492] Sulfurous acid, $H_2SO_3$, is a colorless liquid with the suffocating odor of sulfur. It is made by dissolving sulfur dioxide in water. It is used mainly as sulfur dioxide in aqueous solution. It is an excellent low cost reducing agent. In acid solution, sulfurous acid will also act as an oxidizing agent in the presence of reducing agents such as hydrogen sulfide, hydrogen iodide, reduced metal salts, and zinc. Medicinally, sulfurous acid has been used externally in parasitic skin diseases, as a swab in tonsillitis, and as a gastric antiseptic in pyrosis.

Sulfuryl Fluoride.[1492] Sulfuryl fluoride, $SO_2F_2$, is a colorless and odorless gas. It is prepared according to the following reactions:

(1) $BaCl_2 + 2HSO_3F \longrightarrow Ba(SO_3F)_2 + 2HCl$

(2) $Ba(SO_3F)_2 \xrightarrow{450C} SO_2F_2 + BaSO_4$

(3) $2AgF_2 + SO_2 \longrightarrow SO_2F_2 + 2AgF$

Sulfur Trioxide.[1492, 1570] Sulfur trioxide, $SO_3$, exists in more than one form. $\alpha$-$SO_3$ is a silky, fibrous, needle-like crystal. $\beta$-$SO_3$ is metastable asbestos-like fiber. $\gamma$-$SO_3$ is a metastable, vitreous, orthorhombic crystal or colorless liquid (melting point, 16.8 C). It is prepared by catalytic oxidation of sulfur dioxide. Its major use is as an intermediate in the manufacture of sulfuric acid. Other uses are:

(1) in sulfonation;

(2) in the manufacture of explosives;

(3) in the formation of addition compounds with the amines.

## Sources and Types of Wastes

A large number of chemicals are covered in this report. Some of the chemicals are the basic raw materials in the chemical industry. Hence, the sources of the wastes are very widespread. Generally, they include coal-burning power plants, manufacturers and users of these chemicals in various industrial plants, laboratories, and their distributors. For the same reason, the types of wastes to be expected will include both concentrated and dilute wastes in the exhaust gas and liquid streams.

## Physical and Chemical Properties

Physical and chemical properties of the chemicals in this report are given in the attached worksheets.

## 2. TOXICITY[0766, 1492]

Ammonium hydroxide or ammonia water is irritant to the eyes and mucous membranes. Corneal ulcers have been reported following splashing of ammonia water in the eye. When heated, it emits toxic fumes. Inhalation of concentrated fumes would cause edema of the respiratory tract, spasm of the glottis, and asphyxia.

Toxic effect of boron chloride is not too well known. However, when heated to decomposition, it would emit toxic fumes of chlorides.

Carbon disulfide has a toxic effect on the central nervous system, acting as a narcotic and anesthetic in acute poisoning with death following from respiratory failure. Its anesthetic action is much more powerful than that of chloroform. Poisoning usually occurs from inhalation, but also may be caused by ingestion and skin absorption.

Carbon monoxide is highly poisonous due to its strong affinity for hemoglobin (210 times that of oxygen). It combines with hemoglobin to form the carboxyhemoglobin which is useless as an oxygen carrier. The effect on the body is therefore predominantly that of asphyxia. The symptoms are headache, dizziness, nausea, vomiting, loss of muscular control, unconsciousness, and death.

Hydrochloric acid is strongly corrosive. It is irritant to the mucous membranes of the eyes and the respiratory tract. On contact, concentrated solution would cause severe burns; permanent visual damage may occur. Inhalation of the fume results in cough, choking, and inflammation and ulceration of the respiratory tract. However, in general, hydrochloric acid causes little trouble in industry, other than from accidental splashes and burns.

Hydrofluoric acid is corrosive and poisonous. External contact with liquid or vapor causes severe irritation of the eyes and eyelids which may result in prolonged or permanent visual defects or total destruction of the eyes. Skin contact results in severe burns. Inhalation of vapor may cause extreme irritation of respiratory tract, pulmonary inflammation, congestion, and fluorosis. The symptoms are weight loss, malaise, anemia, leukopenia, and osteosclerosis.

Hydrogen peroxide is not a toxic material. It is, however, a strong oxidizer. Strong solution can cause burns of skin and mucous membranes.

Iodine is one of few elements required by the human body. A normal person needs about 75 mg of iodine a year to satisfy the requirement of the thyroid gland.[1433] Lack of iodine in the body is the cause of goiter.[1570] It is also an antidote to alkaloid poisoning. Iodine vapor is irritating to the lung. But serious exposures are seldom due to the low volatility of the solid. Ingestion of large quantities of iodine would cause abdominal pain, nausea, vomiting and diarrhea.

Mixed acid is a mixture of nitric and sulfuric acids, and its corrosive and toxic effects are those of the constituent acids.

Nitric acid is very corrosive. Its vapor is highly irritating to the skin and the mucous membranes of the eyes and respiratory tract. Continued exposure to the vapor may cause chronic bronchitis and chemical pneumonia. Ingestion of nitric acid causes burning and corrosion of mouth, esophagus, stomach, abdominal tenderness, shock, and death.

Nitrous oxide is not a toxic gas. In fact, it is used as inhalation anesthetic and analgesic. However, in high concentrations, it is narcotic. It is also an asphyxiant.

Silicon tetrachloride may be an irritant to the eyes and respiratory tract but is basically nontoxic. However, when heated to decomposition, it will emit highly toxic fumes of hydrochloric acid. It will also react with water or steam to produce toxic and corrosive fumes.

Sulfur dioxide is corrosive and poisonous. It is dangerous to the eyes because it causes irritation and inflammation of the conjunctiva. It affects the upper respiratory tract and the bronchi. It may cause edema of the lungs or glottis, and can produce respiratory paralysis. Excessive exposure to high enough concentrations of sulfur dioxide can be fatal.

Sulfuric acid is very corrosive to all body tissues. Contact with eyes may result in total loss of vision and skin contact may produce severe necrosis. Inhalation of concentrated vapor may cause serious lung damage. Ingestion may cause severe injury and death.

Sulfurous acid is also corrosive. When heated to decomposition, it emits the toxic fume of sulfur dioxide.

Sulfuryl fluoride is highly irritant and toxic. Inhalation may cause nausea, vomiting, abdominal distress, diarrhea, muscular weakness, convulsions, collapse, respiratory and cardiac failure and death.

Sulfur trioxide is irritant and corrosive to mucous membranes. It may cause coughing, choking, and severe discomfort. When heated to decomposition, it emits highly toxic fumes of oxides of sulfur. It will also react with water or steam to produce toxic and corrosive fumes of sulfuric acid.

The Threshold Limit Value (TLV) recommended by the American Conference of Governmental Industrial Hygienists and the reported lethal doses or concentrations for the chemicals are given below.[0255, 1312]

| Contaminant | TLV | Lethal Dose or Concentration |
|---|---|---|
| Ammonium Hydroxide | 35 mg/M$^3$ ($NH_3$) | or LD: 250 mg($NH_3$)/kg, rat |
| Boron Chloride | -- | ih $LC_{Ca}$: 20 ppm, rat |
| Carbon Disulfide | 60 mg/M$^3$ | sc $LD_{50}$: 300 mg/kg, rabbit |
| Carbon Monoxide | 55 mg/M$^3$ | ih $LC_{Ca}$: 2000 ppm, mouse |
| Hydrochloric Acid (g) | 7 mg/M$^3$ | ih $LC_{Ca}$: 1000 mg/M$^3$, rabbit |
| Hydrofluoric Acid (aq) | | ih $LC_{50}$: 1310 ppm, rat |
| (g) | 2 mg/M$^3$ | ih $LC_{Ca}$: 1000 mg/M$^3$, guinea pig |
| Hydrogen Peroxide | 1.4 mg/M$^3$ | -- |
| Iodine | 1.0 mg/M$^3$ | or $LD_{Ca}$: 30 mg/kg, man |
| Mixed Acids | -- | -- |
| Nitric Acid | 5 mg/M$^3$ | -- |
| Nitrous Oxide | asphyxiant | -- |
| Silicon Tetrachloride | -- | ih $LC_{Ca}$: 8000 ppm, rat |
| Sulfur Dioxide | 13 mg/M$^3$ | ih $LC_{Ca}$: 1000 ppm, rat |
| Sulfuric Acid | 1.0 mg/M$^3$ | ih $LC_{50}$: 500 mg/M$^3$, rat<br>or $LD_{50}$: 2140 mg/kg, rat |
| Sulfurous Acid | -- | -- |
| Sulfuryl Fluoride | 20 mg/M$^3$ | or $LD_{Ca}$: 100 mg/kg, rat |
| Sulfur Trioxide | -- | -- |

## 3. OTHER HAZARDS

Boron chloride hydrolyzes readily in moist air or water to yield corrosive hydrochloric acid. Carbon disulfide is very flammable. It can be ignited by hot steam pipes and presents an acute fire and explosion hazard. Carbon monoxide is also very flammable. Hydrogen peroxide is a powerful oxidizer, particularly the concentrated solution. Heat is generated during hydrogen peroxide decomposition, and hence it is a fire hazard when heated or contacted with flammable materials. Nitrous oxide supports combustion and can form an explosive mixture with air. A shock can shatter the nitrous oxide container with explosive force. Nitric acid is a powerful oxidizing agent, and can cause a moderate fire hazard by chemical reaction with reducing agents. It can also explode on contact with powerful reducing agents. Similarly, sulfuric acid is also a powerful oxidizing agent and can ignite upon contact with combustibles. Also, sulfuric acid has a strong affinity for water, generating much heat in mixing.

## 4. DEFINITION OF ADEQUATE WASTE MANAGEMENT

### Handling, Storage, and Transportation

Corrosive materials such as sulfuric and hydrochloric acid must be handled carefully. Contact with skin and inhalation of the fume should be avoided. They should also be kept away from feed and food products. Flammable chemicals, such as carbon disulfide and carbon monoxide, should be kept away from heat and stored in cool and well-ventilated areas. Powerful oxidizers such as hydrogen peroxide, nitric acid, etc., should be kept away from reducing agents or combustible materials. Practically every chemical treated in this report should be kept tightly closed in its original container. Utmost care must be exercised to prevent the leaking of carbon monoxide from its container, because it is highly poisonous and odorless. It should be stored in a very well-ventilated area.

## Disposal/Reuse

In general, the chemicals discussed in this report could not be economically reprocessed for reuse when they are contaminated or present in the process waste stream. The notable exceptions are iodine, nitric acid, and under certain conditions, sulfuric acid. Iodine is a valuable commodity. Nitric and sulfuric acid wastes are often in concentrated forms and are susceptible to regeneration. For the safe disposal of these chemicals, the recommended maximum exposure limits in air are based on the Threshold Limit Values (TLV) and the recommended maximum exposure limits in water for man and fish are based on U.S. Public Health Service Drinking Water Standards (DWS) or computed from TLV and fish toxicity data.[0225, 1752] These exposure limits are given as follows:

| Contaminant in Air | Maximum Exposure Limit | Basis for Recommendation |
|---|---|---|
| Ammonium Hydroxide | 0.35 mg as $NH_3/M^3$/24 hr | 0.01 TLV |
| Boron Chloride | -- | -- |
| Carbon Disulfide | 0.60 $mg/M^3$/24 hr | 0.01 TLV |
| Carbon Monoxide | 0.55 $mg/M^3$/24 hr | 0.01 TLV |
| Hydrochloric Acid | 0.07 mg (vapor)/$M^3$/24 hr | 0.01 TLV |
| Hydrofluoric Acid | 0.02 mg (vapor)/$M^3$/24 hr | 0.01 TLV |
| Hydrogen Peroxide | 0.014 $mg/M^3$/24 hr | 0.01 TLV |
| Iodine | 0.01 $mg/M^3$/24 hr | 0.01 TLV |
| Mixed Acids | -- | -- |
| Nitric Acid | 0.05 $mg/M^3$/24 hr | 0.01 TLV |
| Nitrous Oxide | -- | -- |
| Silicon Tetrachloride | -- | -- |
| Sulfur Dioxide | 0.13 $mg/M^3$/24 hr | 0.01 TLV |
| Sulfuric Acid | 0.01 mg (vapor)/$M^3$/24 hr | 0.01 TLV |
| Sulfurous Acid | -- | -- |
| Sulfuryl Fluoride | 0.20 $mg/M^3$/24 hr | 0.01 TLV |
| Sulfur Trioxide | -- | -- |

| Contaminant in Water | Exposure Limit, mg/l<br>Man | <br>Fish | Basis for Recommendation |
|---|---|---|---|
| Ammonium Hydroxide | -- | 0.5 | * |
| Boron Chloride | 250 as Cl | -- | DWS |
| Carbon Disulfide | 3.0 | 3.5 | * |
| Carbon Monoxide | 2.75 | 0.01 | * |
| Hydrochloric Acid | 0.35 | 1.0 | * |
| Hydrofluoric Acid | 0.10 | 4.0 | * |
| Hydrogen Peroxide | 0.07 | 4.0 | * |
| Iodine | 0.05 | -- | * |
| Mixed Acid | -- | -- | -- |
| Nitric Acid | 0.25 | 0.1 | -- |
| Nitrous Oxide | -- | -- | -- |
| Silicon Tetrachloride | 250 as Cl | -- | DWS |
| Sulfur Dioxide | 0.65 | 0.05 | * |
| Sulfuric Acid | 0.05 | 1.0 | * |
| Sulfurous Acid | -- | -- | -- |
| Sulfuryl Fluoride | 0.6-1.7 as F | 0.6-1.7 as F | DWS |
| Sulfur Trioxide | -- | -- | -- |

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*Computed values based on the exposure limit in air for man and the critical toxicity concentration for fish.

## 5. EVALUATION OF WASTE RECOVERY/DISPOSAL PROCESSES

### Option No. 1 - Neutralization

Waste streams containing acids, acidic oxides, or bases can be treated by neutralization (1) to form a neutral solution which can then be discharged safely, or (2) to yield an insoluble precipitate which can be removed by filtration. Belonging to this group are:

(1) acids: hydrochloric, hydrofluoric, nitric, sulfuric, sulfurous, and mixed acid;

(2) acidic oxides: sulfur dioxide and trioxide;

(3) bases: ammonium hydroxide.

In addition, certain halides, such as boron chloride, silicon tetrachloride, and sulfuryl fluoride, can be treated in the same manner.

For the acids, acidic oxides and halides, soda ash-slaked lime solution is most commonly used. In the case of sulfuric and hydrofluoric acids, the insoluble calcium sulfate or fluoride is precipitated out and removed by filtration. In the case of nitric and hydrochloric acids, the neutral solution of nitrate or chloride of sodium and calcium is formed and can be discharged after dilution with water. In the case of halides, the corresponding sodium and calcium salt solution is formed. For example, in the case of boron chloride, a solution of chloride and borate of sodium and calcium is formed.

For the removal of sulfur dioxide from a gas stream, there exists a number of processes involving either regenerative or nonregenerative alkaline absorption. These include, among others, various wet limestone scrubbing processes, scrubbing with an aqueous solution of sodium carbonate, sodium sulfite, potassium formate or ammonia, suspension of magnesium oxide, molten carbonate salt solutions, alkaline water, and furnace injection of lime, limestone, and dolomite.*

Ammonium hydroxide may be neutralized by nitric acid to form a solution of ammonium nitrate which can be used as fertilizer.

### Option No. 2 - Fractionation

Carbon disulfide and iodine are volatile materials and can be easily recovered by fractionation. Fractionation is a convenient and economic way to reclaim the waste materials, and is particularly recommended for recovering expensive items such as iodine.

### Option No. 3 - Incineration

Combustible materials can also be disposed of by controlled incinerations. In this group are carbon monoxide, carbon disulfide and nitrous oxide. However, burning of nitrous oxides produces the undesirable oxides of nitrogen, NO and $NO_2$, and therefore incineration is not recommended for the disposal of nitrous oxide. Instead, nitrous oxide can be safely discharged directly into the atmosphere with an excess of air, because it would not lead to the formation of photochemical smog or cause a harmful, toxic effect. Combustion of carbon disulfide produces carbon dioxide and sulfur dioxide. The latter may be treated as in Option No. 1.

### Option No. 4 - Dilution and Decomposition by Water

Concentrated hydrogen peroxide is a powerful oxidizing agent. Rapid decomposition is hazardous. Wasted concentrated hydrogen peroxide can be disposed of by dilution with water to release the oxygen. Agitation would accelerate the decomposition. After decomposition, the waste stream may be discharged safely.

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*The relative merits and the stages of development of the various sulfur dioxide removal processes have been discussed extensively in various technical journals. An excellent paper published recently is "Sulfur Recovery" by G. M. Meisel, in Journal of Metals, May 1972.

## Option No. 5 - Acid Regeneration

The recovery of sulfuric acid from inorganic and organic wastes for reuse are generally not economical,[1662] unless the following specific conditions can be satisfied:[2478]

1. (1) An existing sulfuric acid - producing plant is available at the site where the waste stream is being generated.
2. (2) Concentration of sulfuric acid in the waste must exceed 70 percent.
3. (3) The waste stream to be processed must exceed 50 tons/day.
4. (4) The organic impurities in the waste must not cause excessive consumption of oxygen.
5. (5) The inorganic impurities must be very minor.

In the regeneration process, the spent sulfuric acid stream is thermally decomposed to sulfur dioxide which is then converted back to sulfuric acid in the acid plant by the contact process. If the spent sulfuric acid stream is sufficiently clean but dilute (as in the case of the mixed acid where sulfuric acid is used mainly to absorb the water formed during the nitration process), it can be sent to the acid plant to be fortified for reuse, even though this does not remove the impurities.

Nitric acid forms a constant-boiling azeotrope with water (68% $HNO_3$ + 32% $H_2O$). The normal boiling point of the azeotrope is 120.5 C. Hence, under certain conditions, spent nitric acid can be recovered by stream distillation to yield concentrated acid. On the other hand, the hydrochloric acid-water constant-boiling azeotrope contains only 20.24 percent of HCl. Therefore, regeneration of spent hydrochloric acid by steam distillation is much less desirable.

## Option No. 6 - Gas Adsorption

Recovery of gases may be made by adsorption. The most commonly used gas adsorbents are activated carbon, alumina, silica gel, and various molecular sieves. The adsorption may be carried out in fixed or fluidized beds in single- or multi-stage units. After adsorption, the gases can be regenerated from the adsorbents either under reduced pressures or upon heating by a carrier gas or vapor. For gases which do not react or decompose on contact with water, steam is commonly used as the heating medium. By simple condensation, the steam can be easily separated and removed from the gas-steam mixture. Several activated carbon adsorption processes have been developed to adsorb the sulfur dioxide and convert it into sulfuric acid. None of these processes, however, has reached the commercial production stage.

In addition, regenerative organic absorption processes have also been considered for the removal of sulfur dioxide from the waste gas streams. These include the use of dimethyl aniline, xylidine, hydrazine, sodium citrate and other proprietary organic absorbents. All these processes are still under development and have not been commercialized.

## 6. APPLICABILITY TO NATIONAL DISPOSAL SITES

The materials discussed in this report can be adequately disposed of or recovered in the industrial sites by conventional means. Therefore, it does not appear that consideration for disposal at the National Disposal Sites is warranted. However, some capacity for sulfur dioxide disposal is required at the National Disposal Sites to handle, for example, a secondary waste gas stream containing $SO_2$ generated as the result of processing sulfur-containing wastes or burning of sulfur-containing fuels. Currently, the only proven and applicable commercial $SO_2$ removal process is the Wellman-Lord process of scrubbing the waste gas stream with an aqueous solution of sodium sulfite. Therefore, this process is recommended for the disposal of sulfur dioxide at the National Disposal Sites.

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13

## HAZARDOUS WASTES PROPERTIES WORKSHEET

H. M. Name Ammonium Hydroxide

IUC Name

Common Names

Structural Formula

$NH_4OH$

Molecular Wt. 35.05(1)    Melting Pt. -77 C(1)    Boiling Pt.

Density (Condensed) @    Density (gas) @

Vapor Pressure (recommended 55 C and 20 C)

@    @    @

Flash Point    Autoignition Temp.

Flammability Limits in Air (wt %)    Lower    Upper

Explosive Limits in Air (wt. %)    Lower    Upper

Solubility

Cold Water soluble    Hot Water    Ethanol

Others:

Acid, Base Properties

Highly Reactive with

Compatible with

Shipped in

ICC Classification    Coast Guard Classification

Comments MCA warning label

References (1) 1570

HAZARDOUS WASTES PROPERTIES
WORKSHEET

62

H. M. Name Boron Chloride

IUC Name

Common Names

Structural Formula

$BCl_3$

Molecular Wt. 117.17[(1)] Melting Pt. -107.3 C[(1)] Boiling Pt. 12.5 C[(1)]

Density (Condensed) 1.349 @ 11 C Density (gas) @

Vapor Pressure (recommended 55 C and 20 C)

@ @ @

Flash Point Autoignition Temp.

Flammability Limits in Air (wt %) Lower Upper

Explosive Limits in Air (wt. %) Lower Upper

Solubility

Cold Water Hot Water decomposes Ethanol decomposes

Others:

Acid, Base Properties

Highly Reactive with

Compatible with

Shipped in

ICC Classification Coast Guard Classification

Comments

References (1) 1570

98

## HAZARDOUS WASTES PROPERTIES
## WORKSHEET

H. M. Name Carbon Disulfide

IUC Name

Common Names

Structural Formula

$CS_2$

Molecular Wt. 76.1(1)
Melting Pt. -110.8 C(1)
Boiling Pt. 46.5 C(1)

Density (Condensed) 1.261 @ 20 C
Density (gas) @

Vapor Pressure (recommended 55 C and 20 C)(1)

400 mm Hg @ 28 C

Flash Point -30 C
Autoignition Temp. 125 C

Flammability Limits in Air (wt %) Lower Upper

Explosive Limits in Air (wt. %) Lower Upper

Solubility (2)

Cold Water 0.22 grams/100 ml @ 22 C
Hot Water 0.14 grams/100 ml @ 50C
Ethanol soluble

Others: soluble in ether

Acid, Base Properties

Highly Reactive with

Compatible with

Shipped in

ICC Classification (1)flammable liquid, red label
Coast Guard Classification (1) inflammable liquid, red label

Comments

References (1) 0766
(2) 1570

99

## HAZARDOUS WASTES PROPERTIES WORKSHEET

H. M. Name Carbon Monoxide

IUC Name

Common Names

Structural Formula

CO

Molecular Wt. 28.01(1)

Melting Pt. -207 C(1)

Boiling Pt. -191.3 C(1)

Density (Condensed) 0.793 @

Density (gas) 1.25 grams/l @ 0 C

Vapor Pressure (recommended 55 C and 20 C)

@

@

@

Flash Point

Autoignition Temp. 1204 C

Flammability Limits in Air (vol %)(2) Lower 12 Upper 75

Explosive Limits in Air (wt. %) Lower 12.5 Upper 74.2

Solubility

Cold Water

Hot Water

Ethanol

Others:

Acid, Base Properties

Highly Reactive with

Compatible with

Shipped in

ICC Classification (1) flammable gas, red gas label

Coast Guard Classification (1) flammable gas, red gas label

Comments

References (1) 0766
(2) 1492

214

## HAZARDOUS WASTES PROPERTIES WORKSHEET

H. M. Name Hydrochloric Acid

IUC Name ________________

Common Names ________________

Structural Formula

HCl (aq.)

Molecular Wt. --  Melting Pt. --  Boiling Pt. --

Density (Condensed)________ @____ ____ Density (gas)________ @ ______ ______

Vapor Pressure (recommended 55 C and 20 C)

________ @ ________  ________ @ ________  ________ @ ________

Flash Point ________  Autoignition Temp. ________

Flammability Limits in Air (wt %)  Lower________  Upper________

Explosive Limits in Air (wt. %)  Lower________  Upper________

Solubility

Cold Water________  Hot Water________  Ethanol________

Others:________

Acid, Base Properties strongly acidic

Highly Reactive with________

Compatible with________

Shipped in________

ICC Classification (1) corrosive liquid, white label  Coast Guard Classification (1) corrosive liquid, white label

Comments ________

References (1) 0766

216

## HAZARDOUS WASTES PROPERTIES WORKSHEET

H. M. Name Hydrofluoric Acid

IUC Name

Common Names

Structural Formula

HF (aq.)

Molecular Wt. --

Melting Pt. --

Boiling Pt. --

Density (Condensed) @

Density (gas) @

Vapor Pressure (recommended 55 C and 20 C)

@

@

@

Flash Point

Autoignition Temp.

Flammability Limits in Air (wt %) Lower Upper

Explosive Limits in Air (wt. %) Lower Upper

Solubility

Cold Water Hot Water Ethanol

Others:

Acid, Base Properties acidic

Highly Reactive with

Compatible with

Shipped in

ICC Classification (1) corrosive liquid, white label

Coast Guard Classification (1) corrosive liquid white label

Comments

References (1) 0766

217

## HAZARDOUS WASTES PROPERTIES
## WORKSHEET

H. M. Name Hydrogen Chloride

IUC Name

Common Names

Structural Formula

HCl (g)

Molecular Wt. 36.46(1)    Melting Pt. -114.8 C(1)    Boiling Pt. -84.9 C(1)

Density (Condensed) @    Density (gas) @

Vapor Pressure (recommended 55 C and 20 C)

@    @    @

Flash Point    Autoignition Temp.

Flammability Limits in Air (wt %)    Lower    Upper

Explosive Limits in Air (wt. %)    Lower    Upper

Solubility (1)

Cold Water 82.3 grams/100 ml @ 0 C    Hot Water 56.1 grams/100 ml @ 60 C    Ethanol soluble

Others:

Acid, Base Properties

Highly Reactive with

Compatible with

Shipped in

ICC Classification    Coast Guard Classification (2) noninflammable gas, green gas label

Comments

References (1) 1570
(2) 0766

219

## HAZARDOUS WASTES PROPERTIES WORKSHEET

H. M. Name Hydrogen Peroxide

IUC Name

Common Names

Structural Formula

$H_2O_2$ (aq. >52%)

Molecular Wt. --
Melting Pt. --
Boiling Pt. --

Density (Condensed) @
Density (gas) @

Vapor Pressure (recommended 55 C and 20 C)

@
@
@

Flash Point
Autoignition Temp.

Flammability Limits in Air (wt %) Lower Upper
Explosive Limits in Air (wt. %) Lower Upper

Solubility

Cold Water
Hot Water
Ethanol
Others:

Acid, Base Properties

Highly Reactive with reducing agent

Compatible with

Shipped in

ICC Classification
Coast Guard Classification (1) corrosive liquid white label

Comments

References (1) 0766

233

## HAZARDOUS WASTES PROPERTIES
## WORKSHEET

H. M. Name Iodine (tincture)

IUC Name ______

Common Names ______

Structural Formula

$I_2$

Molecular Wt. 253.809(1) Melting Pt. 113.5 C(1) Boiling Pt. 184.35 C(1)

Density (Condensed) 4.93 @ ______ Density (gas) ______ @ ______

Vapor Pressure (recommended 55 C and 20 C)

______ @ ______ ______ @ ______ ______ @ ______

Flash Point ______ Autoignition Temp. ______

Flammability Limits in Air (wt %) Lower ______ Upper ______

Explosive Limits in Air (wt. %) Lower ______ Upper ______

Solubility (1)

Cold Water 0.029 grams/100 mg @ 20 C Hot Water 0.078 grams/100 ml @ 50 C Ethanol 20.5 grams/100ml @ 15 C

Others: ______

Acid, Base Properties ______

Highly Reactive with ______

Compatible with ______

Shipped in ______

ICC Classification ______ Coast Guard Classification ______

Comments ______

References (1) 1570

277

## HAZARDOUS WASTES PROPERTIES
## WORKSHEET

H. M. Name Mixed Acids

IUC Name

Common Names

Structural Formula

$H_2SO_4 + HNO_3$

Molecular Wt. --   Melting Pt. --   Boiling Pt. --

Density (Condensed) @   Density (gas) @

Vapor Pressure (recommended 55 C and 20 C)

@   @   @

Flash Point   Autoignition Temp.

Flammability Limits in Air (wt %)   Lower   Upper

Explosive Limits in Air (wt. %)   Lower   Upper

Solubility

Cold Water   Hot Water   Ethanol

Others:

Acid, Base Properties

Highly Reactive with

Compatible with

Shipped in

ICC Classification   Coast Guard Classification (1) corrosive liquid, white label

Comments Mixed acid is a mixture of nitric acid and sulfuric acid in various proportions.

References (1) 0766

299

## HAZARDOUS WASTES PROPERTIES
## WORKSHEET

H. M. Name Nitric Acid

IUC Name

Common Names

Structural Formula

$HNO_3$

Molecular Wt. 63.01(1) Melting Pt. -42 C(1) Boiling Pt. 83 C(1)

Density (Condensed) 1.50 @ Density (gas) @

Vapor Pressure (recommended 55 C and 20 C)

@ @ @

Flash Point Autoignition Temp.

Flammability Limits in Air (wt %) Lower Upper

Explosive Limits in Air (wt. %) Lower Upper

Solubility(1)

Cold Water ∞ Hot Water ∞ Ethanol

Others:

Acid, Base Properties strongly acidic

Highly Reactive with

Compatible with

Shipped in

ICC Classification (2) corrosive liquid, white label Coast Guard Classification (2) corrosive liquid, white label

Comments Nitric acid is a powerful oxidizing agent.

References (1) 1570
(2) 0766

313

## HAZARDOUS WASTES PROPERTIES
## WORKSHEET

H. M. Name Nitrous Oxide

IUC Name

Common Names

Structural Formula

$N_2O$

Molecular Wt. 44.01(1) Melting Pt. -90.8 C(1) Boiling Pt. -88.5 C(1)

Density (Condensed) @ Density (gas) @

Vapor Pressure (recommended 55 C and 20 C)

@ @ @

Flash Point Autoignition Temp.

Flammability Limits in Air (wt %) Lower Upper

Explosive Limits in Air (wt. %) Lower Upper

Solubility (1)

Cold Water Hot Water Ethanol soluble

Others: soluble in ether, $H_2SO_4$

Acid, Base Properties

Highly Reactive with

Compatible with

Shipped in

ICC Classification (2) nonflammable gas, green label Coast Guard Classification (2) noninflammable gas, green gas label

Comments

References (1) 1570

(2) 0766

369

# HAZARDOUS WASTES PROPERTIES WORKSHEET

H. M. Name Silicon Tetrachloride

IUC Name

Common Names

Structural Formula

$SiCl_4$

Molecular Wt. 169.90(1) Melting Pt. -70 C(1) Boiling Pt. 57.57 C(1)

Density (Condensed) 1.483 @ 20 C Density (gas) @

Vapor Pressure (recommended 55 C and 20 C)

@ @ @

Flash Point Autoignition Temp.

Flammability Limits in Air (wt %) Lower Upper

Explosive Limits in Air (wt. %) Lower Upper

Solubility(1)

Cold Water decomposes Hot Water decomposes Ethanol decomposes

Others:

Acid, Base Properties

Highly Reactive with

Compatible with

Shipped in

ICC Classification (2) corrosive liquid, white label Coast Guard Classification (2) corrosive liquid white label

Comments

References (1) 1570
(2) 0766

414

## HAZARDOUS WASTES PROPERTIES
## WORKSHEET

H. M. Name Sulfur Dioxide

IUC Name ________________

Common Names ________________

Structural Formula

$SO_2$

Molecular Wt. 64.06(1) Melting Pt. -75.5 C(1) Boiling Pt. -10.0 C(1)

Density (Condensed) 1.434 @ 0 C Density (gas) ________ @ ________

Vapor Pressure (recommended 55 C and 20 C)(1)

2538 mm Hg @ 21.1 C ________ @ ________ ________ @ ________

Flash Point ________ Autoignition Temp. ________

Flammability Limits in Air (wt %) Lower ________ Upper ________

Explosive Limits in Air (wt. %) Lower ________ Upper ________

Solubility

Cold Water ________ Hot Water ________ Ethanol ________

Others: ________

Acid, Base Properties ________

Highly Reactive with ________

Compatible with ________

Shipped in ________

ICC Classification (1) nonflammable gas, green label Coast Guard Classification (1) noninflammable gas, green gas label

Comments ________

References (1) 0766

415

## HAZARDOUS WASTES PROPERTIES WORKSHEET

H. M. Name Sulfuric Acid

IUC Name

Common Names

Structural Formula

$H_2SO_4$

Molecular Wt. 98.98(1) Melting Pt. 10.36 C (100%)(1) Boiling Pt. 338 C (98.3%)(1)

Density (Condensed) 1.841 (96-98%) @ Density (gas) @

Vapor Pressure (recommended 55 C and 20 C)

@ @ @

Flash Point Autoignition Temp.

Flammability Limits in Air (wt %) Lower Upper

Explosive Limits in Air (wt. %) Lower Upper

Solubility

Cold Water ∞ Hot Water ∞ Ethanol decomposes

Others:

Acid, Base Properties strongly acidic

Highly Reactive with

Compatible with

Shipped in

ICC Classification (1) corrosive liquid, white label Coast Guard Classification

Comments

References (1) 0766

416

## HAZARDOUS WASTES PROPERTIES
## WORKSHEET

H. M. Name Sulfurous Acid

IUC Name

Common Names

Structural Formula

$H_2SO_3$

Molecular Wt. 83.08(1)   Melting Pt.   Boiling Pt.

Density (Condensed) Ca 1.03 @   Density (gas) @

Vapor Pressure (recommended 55 C and 20 C)

@   @   @

Flash Point   Autoignition Temp.

Flammability Limits in Air (wt %)   Lower   Upper

Explosive Limits in Air (wt. %)   Lower   Upper

Solubility

Cold Water Soluble   Hot Water   Ethanol Soluble

Others:

Acid, Base Properties Acidic

Highly Reactive with

Compatible with

Shipped in

ICC Classification   Coast Guard Classification

Comments Sulfurous acid exists in solution only. No free sulfurous acid has been isolated.

References (1) 0766

417

## HAZARDOUS WASTES PROPERTIES
## WORKSHEET

H. M. Name Sulfuryl Fluoride

IUC Name

Common Names

Structural Formula

$SO_2F_2$

Molecular Wt. 102.06(1) Melting Pt. -136.7 C(1) Boiling Pt. -55.4 C(1)

Density (Condensed) 1.7 @ Density (gas) @

Vapor Pressure (recommended 55 C and 20 C)

@ @ @

Flash Point Autoignition Temp.

Flammability Limits in Air (wt %) Lower Upper

Explosive Limits in Air (wt. %) Lower Upper

Solubility (1)

Cold Water 10 grams/100 ml @ 0 C Hot Water Ethanol soluble

Others: soluble in $CCl_4$

Acid, Base Properties

Highly Reactive with

Compatible with

Shipped in

ICC Classification Coast Guard Classification

Comments

References (1) 1570

509

## HAZARDOUS WASTES PROPERTIES WORKSHEET

H. M. Name Sulfur Trioxide

IUC Name

Common Names

Structural Formula

$SO_3$

Molecular Wt. 80.06(1)

Melting Pt. α 62.3 C<br>β 32.5 C (1)<br>γ 16.8 C

Boiling Pt. 44.8 C(1)

Density (Condensed) α 1.97(1) @ 20 C
γ 1.92 @ 20 C

Density (gas) @

Vapor Pressure (recommended 55 C and 20 C)

@ @ @

Flash Point

Autoignition Temp.

Flammability Limits in Air (wt %) Lower Upper

Explosive Limits in Air (wt. %) Lower Upper

Solubility(1)

Cold Water decomposes

Hot Water decomposes

Ethanol

Others:

Acid, Base Properties

Highly Reactive with $SO_3$ combines with water with explosive violence to form sulfuric acid.

Compatible with

Shipped in

ICC Classification

Coast Guard Classification

Comments

References (1) 1570

# PROFILE REPORT

## Ammonium Chloride (20), Ammonium Nitrate (24), Potassium Phosphate (351), Dehydrated Borax (381), Sodium Carbonate (383), Sodium Nitrate (396), Sodium Orthophosphates (401)

## 1. GENERAL

### Introduction

The inorganic chemicals in this Profile Report are basically nontoxic. However, when dissolved in water, they may be present in sufficiently large concentrations to constitute a hazard or nuisance. They are grouped together here because they can be handled by similar disposal processes.

### Manufacture and Uses

Ammonium Chloride. Ammonium chloride, $NH_4Cl$, is a white crystalline substance that has a saline taste and is somewhat hygroscopic. The commercial grade is usually produced as a by-product of the Solvay Ammonia-Soda Process (discussed in the paragraph on sodium carbonate). The ammonium chloride is collected from the other products of the ammonia-soda process by crystallization steps carried out under controlled temperature gradients. Another method used for ammonium chloride manufacture is to react ammonium sulfate with sodium chloride in aqueous solution and crystallize ammonium chloride from the resultant mixture. It is used in soldering flux, washing powders, pickling agents for zinc coating and tinning, electroplating and medicine, and in the manufacture of dyes, various ammonia compounds, fertilizer and cement for pipe joints.[0955,1492]

Ammonium Nitrate. Ammonium nitrate, $NH_4NO_3$, a colorless crystalline material, is an important nitrogen fertilizer because of the high nitrogen content (35%) and the simplicity and cheapness of manufacture. It is a vital ingredient in many explosives. A minor, but important, application is in the manufacture of nitrous oxide, an anesthetic. There are four basic processes for the manufacture of ammonium nitrate: prilling or spraying, the Stengel process, crystallization, and graining. All ammonium nitrate is made by neutralizing nitric acid with ammonia and collecting a solid product from the reaction product. To decrease deliquescence and caking and to obtain the best physical characteristics, ammonium nitrate is produced by graining, or prilling. Graining involves batch cooling of a concentrated solution under proper agitation to produce small rounded pellets or grains which can be used for fertilizer or as an explosive. For fertilizer use the ammonium nitrate is prilled by spraying hot concentrated ammonium nitrate solution from the top of a tower and allowing the droplets to cool and harden during the fall, forming solid particles (prills) about 1/16 to 3/32 in. in diameter. After drying and screening, the prills or grains are conditioned against moisture pickup by coating them with a material such as diatomaceous earth.[0955]

Potassium Phosphate. Potassium phosphate, $K_3PO_4$, is a white powder that is soluble in water. It is prepared by the action of phosphoric acid on potassium carbonate. It finds use in water treatment as a sequestering agent. When dissolved in water, a strongly basic solution results.[1492]

Dehydrated Borax. Dehydrated borax, $Na_2B_4O_7$, or sodium tetraborate, is a hygroscopic white crystalline material. It is prepared either from the mineral kernite found in the Mojave Desert or from the saline brines of Searles Lake, California. Borax, $Na_2B_4O_7 \cdot 10H_2O$ is recovered from kernite by dissolving the mineral in water, filtering the solution and crystallizing the borax. Borax and potassium chloride are recovered from Searles Lake. The borax is then collected by crystallization. By heating, borax is dehydrated to the anhydrous form. It is used as a water softner and in the manufacture of glass, enamels and other ceramic products.[0955]

Sodium Carbonate. Sodium carbonate, $Na_2CO_3$, or soda ash--the crude sodium carbonate of commerce, is in the form of a grayish-white powder or lumps that contain 99 percent sodium carbonate. Over 90 percent of the world's production of soda ash is made by the Solvay ammonia-soda process with the remaining quantities being recovered from natural deposits or brines in California and Wyoming. The raw materials for the Solvay process are coke, salt, lime and ammonia. The reactions of the process are as follows:

$$CaCO_3 \xrightarrow{\text{Heat}} CaO + CO_2$$

$$C + O_2 \longrightarrow CO_2$$

$$CaO + H_2O \longrightarrow Ca(OH)_2$$

$$NH_3 + H_2O \longrightarrow NH_4OH$$

$$2NH_4OH + CO_2 \longrightarrow (NH_4)_2CO_3 + H_2O$$

$$(NH_4)_2CO_3 + CO_2 + H_2O \longrightarrow 2NH_4HCO_3$$

$$NH_4HCO_3 + NaCl \longrightarrow NH_4Cl + NaHCO_3$$

$$2NH_4Cl + Ca(OH)_2 \longrightarrow NH_3 + CaCl_2 + H_2O$$

$$2NaHCO_3 \xrightarrow{\text{Heat}} Na_2CO_3 + CO_2 + H_2O$$

Soda ash is used in large quantities by the glass, soap, water treatment, chemical, pulp and paper, petroleum, nonferrous metals and textile industries.[1662]

Sodium Nitrate. Sodium nitrate, $NaNO_3$, is a colorless, transparent, odorless crystalline material. It is prepared by reacting sodium carbonate with nitric acid or by recrystallization of Chile saltpeter which is impure natural sodium nitrate. It is widely used in the chemical industry, in fertilizers and in making explosives such as dynamite.[1492]

Sodium Orthophosphates. The orthophosphates, such as $NaH_2PO_4 \cdot 7H_2O$, and $Na_3PO_4 \cdot 12H_2O$, with the general formula $Na_{3-x}H_xPO_4 (x = 0,1,2)$ are used chiefly in packaged detergents and soaps and in water softening. Sodium dihydrogen phosphate has been used as an ingredient in baking powder. The orthophosphates are prepared by treating soda ash with the proper quantities of phosphoric acid.[1492]

## Physical and Chemical Properties

The physical/chemical properties for the compounds covered by this Profile Report are summarized on the attached worksheets.

## 2. TOXICITY

The materials treated in this report are not considered particularly toxic. However, soda ash and the basic orthophosphates because of their alkalinity are irritating to the skin, and their dust is irritating to the respiratory tract. Boron compounds such as borax may result in accidental poisoning by oral ingestion and toxic reactions in small children may result through skin absorption.[0766] The American Conference of Governmental Industrial Hygienists has not established Threshold Limit Values (TLV) for any of the compounds listed in this report.[0225] The lethal doses reported for the compounds are given below:

| Contaminant | Lethal Dose |
|---|---|
| Ammonium Chloride | im $LD_{50}$: 30 mg/kg, rat |
| Ammonium Nitrate | -- |
| Potassium Phosphate | or $LD_{50}$: 1600 mg/kg, mouse |
| Borax | -- |
| Sodium Carbonate | or $LD_{50}$: 4200 mg/kg, rat |
| Sodium Nitrate | or $LD_{Ca}$: 200 mg/kg, rat |
| Sodium Orthophosphate | ip $LD_{50}$: 328 mg/kg, rat |

## 3. OTHER HAZARDS

Ammonium and sodium nitrate are fire hazards when in contact with organic materials or other readily oxidizable substances. Ammonium nitrate may explode under confinement at high temperature. A mixture of ammonium nitrate and diesel oil is used industrially as an explosive. Explosions have occurred with ammonium nitrate in ship's holds. However, there have been warehouse fires where ammonium nitrate burned and did not detonate. Upon heating, ammonium and sodium nitrate give off toxic fumes of nitrogen oxides.[0955]

## 4. DEFINITION OF ADEQUATE WASTE MANAGEMENT

### Handling, Storage, and Transportation

In storage, the materials in this report require special care only with respect to protection from moisture, their alkaline or acid nature when dissolved in water, and the fire or explosion hazards discussed in Section 3. $Na_3PO_4$ and sodium carbonate are alkaline when dissolved in water and will attack aluminum. $NaH_2PO_4$ is acid when dissolved and will attack many metals. Both ammonium nitrate and sodium nitrate are classified by the Coast Guard and DOT as oxidizing materials that require a Yellow Label.[0766]

### Disposal/Reuse

Industrially contaminated materials may on occasion be reprocessed for reuse. If disposal is to be carried out, safe disposal of these materials is here defined in terms of the recommended provisional limits in air and in water:

| Contaminant in Air | Provisional Limit | Basis for Recommendation |
|---|---|---|
| Ammonium Chloride | 1 mg/M$^3$ | - |

| Contaminant in Water | Provisional Limit | Basis for Recommendation |
|---|---|---|
| Ammonium Chloride | 16 mg/l | Critical level for fish |
| Ammonium Nitrate | 45 mg/l as $NO_3$ | Drinking Water Standard |
| Potassium Phosphate | 750 mg/l | Critical level for fish |
| Borax | 24 mg/l | Critical level for fish |
| Sodium Carbonate | 70 mg/l | Critical level for fish |
| Sodium Nitrate | 45 mg/l as $NO_3$ | Drinking Water Standard |
| Sodium Orthophosphates | 72 mg/l | Critical level for fish |

## 5. EVALUATION OF WASTE DISPOSAL PROCESSES

### Option No. 1 - Dilution and Discharge

The Manufacturing Chemists Association has recommended disposal of all the materials in this report by discharge into sewers after neutralization and dilution. If each of the materials are diluted to the levels indicated in Section 4 as recommended provisional limits in water and the pH is adjusted to between 6.5 and 9.1, the materials can be discharged into sewers or natural streams.[0095]

### Option No. 2 - Treatment with Sodium Hydroxide

Both ammonium nitrate and ammonium chloride upon treatment with sodium hydroxide liberate ammonia and form soluble sodium salts, either the chloride or nitrate. The liberated ammonia can be recovered and sold. After dilution to the limits noted in Section 4, sodium nitrate or sodium chloride can be discharged into a stream or sewer.

Option No. 3 - Incineration

Ammonium nitrate and ammonium chloride after dilution with water can be charged into a gas fed incinerator. The $NO_x$ and/or HCl formed must be removed by scrubber. Though this method is possible, it is not in wide use.

## 6. APPLICABILITY TO NATIONAL DISPOSAL SITES

The materials discussed in this report have been classified on a preliminary basis as probable candidates for municipal disposal. Based on the discussion of disposal in Section 5, it may be concluded that the waste treatment of these compounds can be adequately handled locally and no consideration for National Disposal Site treatment is warranted.

# 7. REFERENCES

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## HAZARDOUS WASTES PROPERTIES
## WORKSHEET

H. M. Name Ammonium Chloride

IUC Name Ammonium Chloride

Common Names Sal Ammoniac

Structural Formula

$NH_4Cl$

Molecular Wt. 53.50(2) Melting Pt. - Boiling Pt. 350 C sublimes(1)

Density (Condensed) 1.54(1) @ Density (gas) @

Vapor Pressure (recommended 55 C and 20 C)

@ @ @

Flash Point Autoignition Temp.

Flammability Limits in Air (wt %) Lower Upper

Explosive Limits in Air (wt. %) Lower Upper

Solubility

Cold Water 29.7g/100g at 0 C(2) Hot Water 75.8g/100g at 100 C(2) Ethanol slightly soluble

Others: soluble - $NH_4OH$

Acid, Base Properties Acid in aqueous solution due to hydrolysis.

Highly Reactive with Liberates ammonia when treated with sodium hydroxide

Compatible with

Shipped in barrels, multiwall paper sacks

ICC Classification none(1) Coast Guard Classification none(1)

Comments

References (1) 1492
(2) 1570

# HAZARDOUS WASTES PROPERTIES
# WORKSHEET

H. M. Name Ammonium Nitrate

IUC Name Ammonium Nitrate

Common Names Norway Saltpeter

Structural Formula

$NH_4NO_3$

Molecular Wt. 80.05 Melting Pt. 169.6 C(1) Boiling Pt. 210 decomposes(1)

Density (Condensed) 1.725g/cc @ 23 C Density (gas) @

Vapor Pressure (recommended 55 C and 20 C)

@ @ @

Flash Point Autoignition Temp.

Flammability Limits in Air (wt %) Lower Upper

Explosive Limits in Air (wt. %) Lower Upper

Solubility

Cold Water 118g/100g at 0 C(2) Hot Water 871g/100g at 100 C(2) Ethanol 2.8g/100g at 20 C(2)

Others: alkalies - soluble

Acid, Base Properties

Highly Reactive with Reacts with strong alkalies to liberate ammonia. The mixture of ammonium nitrate with diesel oil is used as an industrial explosive.

Compatible with

Shipped in Bags, carloads, truckloads

ICC Classification Oxidizing material Coast Guard Classification Oxidizing material

Comments

References (1) 1492
(2) 1570

# HAZARDOUS WASTES PROPERTIES
# WORKSHEET

H. M. Name Potassium Phosphate

IUC Name Potassium Phosphate, Tribasic

Common Names

Structural Formula

$K_3PO_4$

Molecular Wt. 212.31(2)    Melting Pt. 1340 C    Boiling Pt.

Density (Condensed) @    Density (gas) @

Vapor Pressure (recommended 55 C and 20 C)

@    @    @

Flash Point    Autoignition Temp.

Flammability Limits in Air (wt %)    Lower    Upper

Explosive Limits in Air (wt. %)    Lower    Upper

Solubility

Cold Water Soluble(1)    Hot Water Soluble (1)    Ethanol Insoluble(1)

Others:

Acid, Base Properties Strong base in water(1)

Highly Reactive with

Compatible with

Shipped in 275, 300, 400-lb drums(1)

ICC Classification None(1)    Coast Guard Classification None(1)

Comments Hygroscopic(1)

References (1) 1492
(2) 1570

## HAZARDOUS WASTES PROPERTIES
## WORKSHEET

H. M. Name Borax Dehydrated

IUC Name Sodium Tetraborate

Common Names

Structural Formula

$Na_2B_4O_7$

Molecular Wt. 201.27(2) Melting Pt. 741 C(1) Boiling Pt. 1575 Cd(2)

Density (Condensed) 2.367g/cc @ 23 C(1) Density (gas) @

Vapor Pressure (recommended 55 C and 20 C)

@ @ @

Flash Point Autoignition Temp.

Flammability Limits in Air (wt %) Lower Upper

Explosive Limits in Air (wt. %) Lower Upper

Solubility

Cold Water 1.49g/100g at 0 C(2) Hot Water 8.79g/100g at 40 C(2) Ethanol Insoluble(2)

Others:

Acid, Base Properties

Highly Reactive with

Compatible with

Shipped in 100 lb paper bags, boxcars(1)

ICC Classification None(1) Coast Guard Classification None(1)

Comments Hygroscopic(1)

References (1) 1492
(2) 1570

## HAZARDOUS WASTES PROPERTIES
## WORKSHEET

H. M. Name Sodium Carbonate

IUC Name Sodium Carbonate

Common Names Soda Ash

Structural Formula

$Na_2CO_3$

Molecular Wt. 106.00(2)    Melting Pt. 851 C(2)    Boiling Pt. decomposes(2)

Density (Condensed) 2.509 @ 0 C(2)    Density (gas) ____ @ ____ ____

Vapor Pressure (recommended 55 C and 20 C)

____ @ ____    ____ @ ____    ____ @ ____

Flash Point ____    Autoignition Temp. ____

Flammability Limits in Air (wt %)    Lower ____    Upper ____

Explosive Limits in Air (wt. %)    Lower ____    Upper ____

Solubility

Cold Water 7.1g/100 ml at 0 C(2)    Hot Water 45.5g/100 ml at 100 C(2)    Ethanol Insoluble

Others: ____

Acid, Base Properties Alkaline(1)

Highly Reactive with Acids(1)

Compatible with ____

Shipped in Bags, barrels, drums, bulk(1)

ICC Classification None(1)    Coast Guard Classification None(1)

Comments ____

References (1) 1492
(2) 1570

## HAZARDOUS WASTES PROPERTIES
## WORKSHEET

H. M. Name Sodium Nitrate

IUC Name Sodium Nitrate

Common Names Chile Saltpeter

Structural Formula

$NaNO_3$

Molecular Wt. 85.01(2) Melting Pt. 308 C(2) Boiling Pt. Decomposes(2)

Density (Condensed) 2.267 @ 20 C(1) Density (gas) ____ @ ____

Vapor Pressure (recommended 55 C and 20 C)

____ @ ____ ____ @ ____ ____ @ ____

Flash Point ____ Autoignition Temp. ____

Flammability Limits in Air (wt %) Lower ____ Upper ____

Explosive Limits in Air (wt. %) Lower ____ Upper ____

Solubility

Cold Water 73g/100 ml at 0 C(2) Hot Water 180g/100 ml at 100 C(2) Ethanol Slightly Soluble(1)

Others: Glycerol - soluble

Acid, Base Properties ____

Highly Reactive with Organic matter

Compatible with ____

Shipped in Tins, glass bottles, bags up to 100 lb, bulk(1)

ICC Classification ozidizing material(1) Coast Guard Classification oxidizing material(1)

Comments ____

References (1) 1492
(2) 1570

## HAZARDOUS WASTES PROPERTIES
## WORKSHEET

H. M. Name Sodium Phosphate

IUC Name Sodium Phosphate, Monobasic

Common Names

Structural Formula

$NaH_2PO_4 \cdot H_2O$

Molecular Wt. 138.05(1) Melting Pt. 200C-$H_2O$(1) Boiling Pt. 200 C-2$H_2O$(1)

Density (Condensed) 2.040g/cc @ 20 C(1) Density (gas) @

Vapor Pressure (recommended 55 C and 20 C)

@ @ @

Flash Point Autoignition Temp.

Flammability Limits in Air (wt %) Lower Upper

Explosive Limits in Air (wt. %) Lower Upper

**Solubility**

Cold Water 59.9g/100 ml at 0 C(1) Hot Water 427g/100 ml at 100 C(1) Ethanol insoluble(1)

Others:

Acid, Base Properties Acid(2)

Highly Reactive with

Compatible with

Shipped in Bags, drums, barrels

ICC Classification None(2) Coast Guard Classification None(2)

Comments

References (1) 1570
(2) 1492

# HAZARDOUS WASTES PROPERTIES WORKSHEET

H. M. Name Sodium Phosphate

IUC Name Sodium Phosphate, Dibasic

Common Names

Structural Formula

$Na_2HPO_4 \cdot 2H_2O$

Molecular Wt. 178.05(1) Melting Pt. 92.5 C-$H_2O$ Boiling Pt.

Density (Condensed) 2.066 @ 15 C(1) Density (gas) @

Vapor Pressure (recommended 55 C and 20 C)

@ @ @

Flash Point Autoignition Temp.

Flammability Limits in Air (wt %) Lower Upper

Explosive Limits in Air (wt. %) Lower Upper

Solubility

Cold Water 82.5g/100 ml at 50 C(1) Hot Water 96.6g/100 ml at 80 C(1) Ethanol slightly soluble

Others:

Acid, Base Properties

Highly Reactive with

Compatible with

Shipped in Bags, fiber drums, barrels(2)

ICC Classification none(2) Coast Guard Classification none(2)

Comments

References (1) 1570
(2) 1492

## HAZARDOUS WASTES PROPERTIES
## WORKSHEET

H. M. Name Sodium Phosphate

IUC Name Sodium Phosphate, Tribasic

Common Names

Structural Formula

$Na_3PO_4 \cdot 10H_2O$

Molecular Wt. 344.17(1) Melting Pt. 100 C(1) Boiling Pt.

Density (Condensed) 2.536g/cc @ 175 C(1) Density (gas) @

Vapor Pressure (recommended 55 C and 20 C)

@ @ @

Flash Point Autoignition Temp.

Flammability Limits in Air (wt %) Lower Upper

Explosive Limits in Air (wt. %) Lower Upper

Solubility

Cold Water 1.5g/100 ml at 10 C(1) Hot Water 157g/100 ml at 100 C(1) Ethanol

Others:

Acid, Base Properties Basic(2)

Highly Reactive with

Compatible with

Shipped in 1, 5-lb bottles, barrels, bags(2)

ICC Classification None(2) Coast Guard Classification None(2)

Comments

References (1) 1570
(2) 1492

# PROFILE REPORT

## Ammonium Perchlorate (25), Ammonium Persulfate (26), Sodium Hypochlorite (222), Magnesium Chlorate (246), Sodium Carbonate Peroxide (384), Sodium Perchlorate (399), Zinc Chlorate (455), Calcium Hypochlorite (482)

## 1. GENERAL

### Introduction

The inorganic chemicals in this Profile Report are basically nontoxic. However, they are oxidizing agents that constitute fire or explosion hazards. They are grouped together because they can be handled by similar disposal processes.

### Manufacture and Uses

Ammonium Perchlorate. Ammonium perchlorate, $NH_4ClO_4$, is a white crystalline material, which is made by a six-operation process which involves reacting sodium perchlorate, ammonia, and hydrochloric acid in an aqueous medium. After cooling and concentrating the reaction mixture by flash evaporation, ammonium perchlorate comes out of solution in a crystallizer, under closely controlled conditions. The $NH_4ClO_4$ crystals are separated from the slurry by centrifugation, washed, and reslurried in saturated $NH_4ClO_4$ solution. The second $NH_4ClO_4$ slurry is centrifuged, and the $NH_4ClO_4$ cake produced is washed, dried and sized. The filtrate from the first centrifugation is concentrated to permit crystallization of the excess NaCl present. The slurry produced is centrifuged, and the filtrate returned to the first operation as a raw material. The crystalline NaCl is washed and dried for sale as a by-product.[2489] Ammonium perchlorate is used as an ingredient of explosives, in solid propellant compositions, in pyrotechnic compositions, and as a raw material for the production of perchloric acid and numerous metallic perchlorates.

Ammonium Persulfate. Ammonium persulfate, $(NH_4)_2S_2O_8$, is a strong oxidizing material that occurs as white crystals. It is prepared by electrolysis of acid solutions of ammonium sulfate using electrolytic cells having a stationary catholyte. Usually platinum anodes and graphite cathodes are employed. The ammonium persulfate is recovered by crystallization. Its uses include the manufacture of hydrogen peroxide, the oxidation of inorganic and organic compounds, and electroplating.[0955]

Sodium Hypochlorite. Sodium hypochlorite, NaOCl, exists only in aqueous solution. The aqueous solutions generally contain sodium hydroxide. It is employed as a disinfectant and deodorant in dairies, creameries, water supplies, sewage disposal and as a bleaching agent for cotton, linen, jute, paper pulp and oranges. The most common method of manufacture is the reaction between sodium hydroxide solution and gaseous chlorine.

$$Cl_2 + 2NaOH \longrightarrow NaCl + H_2O + NaOCl$$

Another method formerly in wide use was the electrolysis of a concentrated salt solution. The electrolytic cells used to manufacture NaOCl did not have any diaphragm and were operated at high current density in nearly neutral solution. The cells were designed with the chlorine given off at the anode.[1662]

Magnesium Chlorate. Magnesium chlorate, $Mg(ClO_3)_2$, is a white hygroscopic powder that has a bitter taste. It is prepared by reacting magnesium chloride and sodium chlorate followed by crystallization of magnesium chlorate. It is used in medicine, as a defoliant and as a desiccant.[1416]

Sodium Carbonate Peroxide. Sodium carbonate peroxide, $2Na_2CO_3 \cdot 3H_2O_2$, is a white crystalline powder that is stable at room temperature when dry but decomposes rapidly at 100 C. It is prepared by crystallization from a solution of soda ash and hydrogen peroxide. It is used in household detergents, dental cleansers, bleaching and dyeing compounds, and in formulations for the modification of starch.[1416,1662]

Sodium Perchlorate. Sodium perchlorate, $NaClO_4$, forms white deliquescent crystals. It is prepared by the electrolysis of sodium in steel electrolytic cells which have smooth platinum anodes or lead dioxide anodes and operate at 6.5 to 7.0 volts, 2,500 amps., and at a temperature of 35 to 50 C. The solution is concentrated and crystallized.[2489] $NaClO_4$ is used as analytical reagent and to a limited extent in explosives.[1416] The major use is in the preparation of ammonium perchlorate.[2489]

Zinc Chlorate. Zinc chlorate, $Zn(ClO_3)_2 \cdot 4H_2O$, is a colorless to yellow deliquescent crystalline material. It decomposes at 60 C. It is prepared by reacting zinc chloride with a solution of sodium chlorate followed by crystallization.[1416]

Calcium Hypochlorite. Calcium hypochlorite, $Ca(OCl)_2$ is a white, crystalline solid. It is prepared by chlorination of a slurry of lime and caustic soda with subsequent precipitation of calcium hypochlorite dihydrate which is dried under vacuum. It is used as a algicide, fungicide and bleaching agent.[1662]

## Physical/Chemical Properties

The physical/chemical properties of the compounds covered by this Profile Report are summarized on the attached worksheets.

## 2. TOXICITY

The materials treated by this report are not considered particularly toxic. The American Conference of Government Industrial Hygienists has not established Threshold Limit Values (TLV) for any of the compounds listed in this report nor have any provisional maximum concentrations in water for man been established.[0225,1536] Perchlorates are irritating to the skin and mucous membranes. Chlorates and persulfates can irritate the gastrointestinal tract. If absorbed, chlorates can cause hemolysis of red blood cells, methemoglobinemia, liver and kidney damage. Five grams of chlorate salt is considered a toxic dose for adults.[1142] Hypochlorites and peroxides are irritating to the skin and mucous membranes.

## 3. OTHER HAZARDS

All of the materials included in this report are oxidizing materials and contact with combustible material should be avoided. The perchlorates are powerful oxidizers that explode violently when heated with sulfur, organic matter, or finely divided metal, particularly magnesium and aluminum. Large exotherms occur upon heating. The chlorates explode when exposed to heat or shock and when rubbed in the presence of organic or reducing materials.[1142]

## 4. DEFINITION OF ADEQUATE WASTE MANAGEMENT

### Handling, Storage and Transportation

All the materials in this report must be handled in such a manner that they do not come into contact with reducing substances. They should not be exposed to heat. Contact with the skin should be avoided. Ammonium perchlorate, magnesium chlorate, sodium perchlorate, zinc chlorate, and calcium hypochlorite are classified by DOT and the Coast Guard as oxidizing materials that require a Yellow Label.[0776] The other materials do not have shipping regulations.

### Disposal/Reuse

Industrially, contaminated materials discussed in this report are not usually reprocessed for reuse since these materials are oxidizing agents that may ignite or explode easily when contaminated with organic or reducing materials. When disposal of these materials is required, the disposal process effluent must meet the following recommended provisional limits.

| Contaminant in Water | Provisional Limit | Basis |
|---|---|---|
| Ammonium Perchlorate | 0.05 mg/l | Derived from $NaClO_4$ limit for fish |
| Ammonium Persulfate | Unknown | -- |
| Sodium Hypochlorite | 0.003 ppm as $Cl_2$ | Derived from $Cl_2$ limit for fish |
| Magnesium Chlorate | 125 mg/l | DWS |
| Sodium Perchlorate | 0.05 mg/l | Limit for fish |
| Zinc Chlorate | 5 ppm as Zn | DWS |
| Calcium Hypochlorite | 0.003 ppm as $Cl_2$ | Derived from $Cl_2$ limit for fish |
| Sodium Carbonate Peroxide | 40 ppm as $H_2O_2$ | Derived from $Na_2O_2$ limit for fish |

## 5. EVALUATION OF WASTE DISPOSAL PROCESSES

### Option No. 1 - Reduction

Disposal of oxidizing agents covered by this report may be accomplished by dissolving the material, adding the resultant solution to a large volume of a concentrated solution of reducing agent (sodium thiosulfate, sodium bisulfite, or a ferrous salt), and then acidifying the mixture with 3M-$H_2SO_4$. When reduction is complete, soda ash is added to make the solution alkaline. (If an ammonium salt is present, ammonia will be liberated and will require recovery.) The alkaline liquid is decanted from any sludge produced, neutralized, and diluted before discharge to a sewer or stream.[0095] The sludge (if magnesium or zinc are present) is added to a landfill. This process is considered satisfactory for treatment of the materials covered by this report.

### Option No. 2 - Open Burning

Uncontaminated oxidizers, particularly the perchlorate reject materials, process fines, or overruns from grinding or blending operations, are collected and transported to "burn sites" in open-top 30-gallon drums, with lids attached. At the burn sites the oxidizers are spread thinly over a layer of excelsior or other flammable dry materials. The flammable materials are ignited by a squib, fired electrically, with the controls at a safe distance. Contaminated materials are left in the containers in which they are collected and the material burned in the container in a similar manner.[1142] Though this process is widely used at solid propellant manufacturing sites, it is not considered satisfactory because large quantities of $NO_x$ and HCl are liberated.

### Option No. 3 - Incineration

Though not in wide use, dilute aqueous solutions of all the materials covered by this report can be destroyed by injection into an incinerator supported by a gas flame. Scrubbers are required to remove HCl, $NO_x$, and metal oxide particles from the incinerator vent gases. Properly designed and operated incineration is considered a promising near-future method for the disposal of the oxidizers in this report, but additional research is required before wide use.

## 6. APPLICABILITY TO NATIONAL DISPOSAL SITES

The hypochlorite wastes can be treated by the Option No. 1 process at their site of origin, and are not considered candidates for National Disposal Site treatment. The chlorates, perchlorates, ammonium persulfate and sodium carbonate-peroxide can be treated locally, but because of their hazardous nature, it will be advisable to dispose of these materials by Option No. 1 or 3 at National Disposal Sites.

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## HAZARDOUS WASTES PROPERTIES WORKSHEET

H. M. Name Ammonium Perchlorate

IUC Name Ammonium Perchlorate

Common Names

Structural Formula

$NH_4ClO_4$

Molecular Wt. 117.5(1) Melting Pt. 150 C decomposes Boiling Pt. decomposes

Density (Condensed) 1.95g/cc @ 20 C(1) Density (gas) @

Vapor Pressure (recommended 55 C and 20 C)

@ @ @

Flash Point Autoignition Temp.

Flammability Limits in Air (wt %) Lower Upper

Explosive Limits in Air (wt. %) Lower Upper

Solubility

Cold Water 20g/100 ml at 25 C(1) Hot Water 88 g/100 ml at 100 C(1) Ethanol 9.908 g/100 g(1)

Others: Acetone 2.2 6 g/100 g

Acid, Base Properties

Highly Reactive with reducing material

Compatible with

Shipped in metal drums with polyethylene liners.

ICC Classification oxidizing material(1) Coast Guard Classification oxidizing material(1)

Comments

References (1) 1142

## HAZARDOUS WASTES PROPERTIES
## WORKSHEET

H. M. Name Magnesium Chlorate

IUC Name Magnesium Chlorate

Common Names

Structural Formula

$Mg(ClO_3)_2 \cdot 6H_2O$

Molecular Wt. 299.33 Melting Pt. 251 C decomp. Boiling Pt.

Density (Condensed) 180 g/cc @ 25 C (1) Density (gas) @

Vapor Pressure (recommended 55 C and 20 C)

@ @ @

Flash Point Autoignition Temp.

Flammability Limits in Air (wt %) Lower Upper

Explosive Limits in Air (wt. %) Lower Upper

Solubility

Cold Water 49.90 g/100 ml at 25 C (1) Hot Water very soluble Ethanol

Others:

Acid, Base Properties

Highly Reactive with

Compatible with

Shipped in glass bottles (2)

ICC Classification oxidizing material (2) Coast Guard Classification Oxidizing Material (2)

Comments

References (1) 1570
(2) 1416

## HAZARDOUS WASTES PROPERTIES
## WORKSHEET

H. M. Name Sodium Carbonate Peroxide

IUC Name ________________

Common Names ________________

Structural Formula

$2Na_2CO_3 \cdot 3H_2O_2$

Molecular Wt. not a true compound　Melting Pt. decomposes above 100 C　Boiling Pt. ________

Density (Condensed) ________ @ ____ ____ Density (gas) ________ @ ____ ____

Vapor Pressure (recommended 55 C and 20 C)

________ @ ________　________ @ ________　________ @ ________

Flash Point ________　Autoignition Temp. ____

Flammability Limits in Air (wt %)　Lower ________　Upper ________

Explosive Limits in Air (wt. %)　Lower ________　Upper ________

Solubility

Cold Water soluble　Hot Water ________　Ethanol ________

Others: ________

Acid, Base Properties ________

Highly Reactive with reducing substances

Compatible with ________

Shipped in 100 lb fiber drums

ICC Classification None　Coast Guard Classification None

Comments ________

References (1) 1416

## HAZARDOUS WASTES PROPERTIES
## WORKSHEET

H. M. Name Sodium Perchlorate

IUC Name Sodium Perchlorate

Common Names

Structural Formula

$NaClO_4$

Molecular Wt. 122.45(1) Melting Pt. 482 C Decomp. Boiling Pt.

Density (Condensed) 2.0 2g/cc @ 20 C(1) Density (gas) @

Vapor Pressure (recommended 55 C and 20 C)

@ @ @

Flash Point Autoignition Temp.

Flammability Limits in Air (wt %) Lower Upper

Explosive Limits in Air (wt. %) Lower Upper

Solubility

Cold Water 209g/100 ml at 15 C (1) Hot Water 284 g/100 ml at 50 C Ethanol Soluble

Others:

Acid, Base Properties

Highly Reactive with

Compatible with

Shipped in bottles, drums, kegs

ICC Classification oxidizing material (2) Coast Guard Classification Oxidizing Material

Comments

References (1) 1570
(2) 1416

## HAZARDOUS WASTES PROPERTIES
## WORKSHEET

H. M. Name Zinc Chlorate

IUC Name Zinc Chlorate

Common Names

Structural Formula

$Zn(ClO_3)_2 \cdot 4H_2O$

Molecular Wt. 304.36 (1)　Melting Pt. 60 C decomp.　Boiling Pt.

Density (Condensed) 2.15 g/cc @ 20 C (1)　Density (gas) @

Vapor Pressure (recommended 55 C and 20 C)

@　@　@

Flash Point　Autoignition Temp.

Flammability Limits in Air (wt %)　Lower　Upper

Explosive Limits in Air (wt. %)　Lower　Upper

Solubility

Cold Water 262 g/100 ml at 20 C　Hot Water very soluble　Ethanol 167 g/100 ml

Others: ether-soluble

Acid, Base Properties

Highly Reactive with

Compatible with

Shipped in

ICC Classification oxidizing material (2)　Coast Guard Classification Oxidizing Material (2)

Comments

References (1) 1570
(2) 1416

## HAZARDOUS WASTES PROPERTIES
## WORKSHEET

H. M. Name Calcium Hypochlorite

IUC Name Calcium Hypochlorite

Common Names

Structural Formula

$Ca(OCl)_2 \cdot 4H_2O$

Molecular Wt. 215.06 Melting Pt. Boiling Pt.

Density (Condensed) @ Density (gas) @

Vapor Pressure (recommended 55 C and 20 C)

@ @ @

Flash Point Autoignition Temp.

Flammability Limits in Air (wt %) Lower Upper

Explosive Limits in Air (wt. %) Lower Upper

Solubility

Cold Water very soluble Hot Water decomposes Ethanol decomposes

Others:

Acid, Base Properties

Highly Reactive with

Compatible with

Shipped in

ICC Classification none Coast Guard Classification none

Comments

References (1) 1570

## HAZARDOUS WASTES PROPERTIES
## WORKSHEET

H. M. Name Ammonium Persulfate

IUC Name Ammonium Persulfate

Common Names

Structural Formula

$(NH_4)_2S_2O_8$

Molecular Wt. 228.20(1) Melting Pt. 120 C decomposes(1) Boiling Pt.

Density (Condensed) 1.982 g/cc @ 20 C (1) Density (gas) @

Vapor Pressure (recommended 55 C and 20 C)

@ @ @

Flash Point Autoignition Temp.

Flammability Limits in Air (wt %) Lower Upper

Explosive Limits in Air (wt. %) Lower Upper

Solubility

Cold Water 70.6 g/100 ml at OC(1) Hot Water 103.8 g/100 ml at 100 C Ethanol Insoluble(1)

Others: Acetone - insoluble (1)

Acid, Base Properties

Highly Reactive with reducing materials(1)

Compatible with

Shipped in bottles, drums

ICC Classification None(2) Coast Guard Classification None(2)

Comments

References (1) 1570
(2) 1416

## HAZARDOUS WASTES PROPERTIES
## WORKSHEET

H. M. Name Sodium Hypochlorite

IUC Name Sodium Hypochlorite

Common Names

Structural Formula

NaOCl

Molecular Wt. 74.45 (1)    Melting Pt. --    Boiling Pt. --

Density (Condensed) @    Density (gas) @

Vapor Pressure (recommended 55 C and 20 C)

@    @    @

Flash Point    Autoignition Temp.

Flammability Limits in Air (wt %)    Lower    Upper

Explosive Limits in Air (wt. %)    Lower    Upper

Solubility

Cold Water Soluble    Hot Water    Ethanol

Others:

Acid, Base Properties Solution is strongly basic

Highly Reactive with reducing agents

Compatible with

Shipped in glass carboys, drums (1)

ICC Classification None (1)    Coast Guard Classification None (1)

Comments present only in solution

References (1) 1416

## PROFILE REPORT

Ammonium Sulfide (29), Antimony Pentachloride (35), Antimony Trichloride (41), Calcium Carbide (89), Calcium Hydride (93), Lithium Aluminum Hydride (244), Potassium Binoxalate (342), Potassium Hydroxide (347), Potassium Oxalate (348), Sodium Amide (375), Sodium Hydride (391), Sodium Hydrosulfite (392), Sodium Oxalate (398), Sodium Sulfide (404), Sodium Thiocyanate (406), Stannic Chloride (408), Thiocyanates (432)

## 1. GENERAL

### Introduction

The inorganic materials included in this Profile Report have been preliminarily identified as probable candidates for industrial disposal. These materials either dissolve readily in water or react with water violently. Their toxicities vary from irritating and corrosive to skin to highly toxic. Many of them emit corrosive and/or toxic fumes when heated to decomposition or by chemical reactions on contact with water or moisture in air. Most of them are not produced in large tonnage.

### Manufacture and Uses[1433, 1492]

Ammonium Sulfide. Ammonium sulfide, $(NH_4)_2S$, is a colorless crystal at temperatures below -18 C. At higher temperatures, it decomposes into ammonia and ammonium hydrosulfide ($NH_4HS$). Ammonium sulfide is prepared by reacting excess of ammonia with hydrogen sulfide. It has limited uses in (1) the application of patina to bronze; (2) photographic developers; and (3) textile manufacture.

Antimony Pentachloride. Antimony Pentachloride, $SbCl_5$, is a yellow, oily liquid. It loses chlorine readily. The decomposition is appreciable even at 12 C. It is prepared by passing chlorine gas into molten antimony trichloride. It is used as a catalyst when replacing a fluorine substituent with chlorine in organic compounds.

Antimony Trichloride. Antimony trichloride, $SbCl_3$, is a colorless, rhombic, and deliquescent crystal. It fumes in air. It is prepared by direct chlorination of antimony trioxide, antimony trisulfide or antimony. Its uses are:

(1) as a catalyst;

(2) as a mordant in calico printing;

(3) in the manufacture of other antimony salts and organic syntheses;

(4) as a chemical reagent.

Calcium Carbide. Calcium carbide, $CaC_2$, is a colorless, orthorhombic crystal or in grayish-black, irregular lumps. It decomposes readily on contact with water, producing acetylene gas. It is produced by heating lime and carbon (usually coke or anthracite) in an electric furnace at 2000 to 2200 C. In 1969, 920,000 tons of calcium carbide were produced in the United States.[1929] Its uses are:

(1) in generating acetylene for lighting (largest use), and welding and cutting metals;

(2) in the manufacture of calcium cyanamide and lampblack;

(3) as a reducing, dyhydrating or desulfurizing agent in various chemical and metallurgical processes;

(4) in signal fires for marine services.

Calcium Hydride. Calcium hydride, $CaH_2$, is a white rhombic crystal. It decomposes on contact with water. Commercially, it is produced by reacting calcium with hydrogen at atmospheric pressure and a temperature of 300 C. Its uses are:

(1) in the production of rare metals such as titanium, zirconium, vanadium, niobium, uranium, and thorium from their oxides;

(2) as a drying agent for drying esters, ketones, halides, air, hydrogen, other gases, etc.;

(3) as a source of hydrogen.

Lithium Aluminum Hydride. Lithium aluminum hydride, $LiAlH_4$, is a white crystalline powder. It is stable in dry air at room temperatures, but it will decompose at a temperature above 125 C or in moist air. It is prepared by the addition of an ether solution of aluminum chloride to a slurry of lithium hydride in ether. It can also be prepared from its elements at 2000 psi and 100 C. It is used as a reducing agent and in the preparation of other hydrides and organic compounds.

Potassium Binoxalate. Potassium binoxalate, $KHC_2O_4$, also called potassium acid oxalate, is a colorless, odorless, monoclinic crystal. It is used in removing ink stains, scouring metals, cleaning wood, photography. bleaching stearin, and as a mordant in dyeing.

Potassium Hydroxide. Potassium hydroxide, KOH, is in the form of white or slightly yellow lumps, rods or pellets. It rapidly absorbs moisture and carbon dioxide from the air and deliquesces. Commercially, it is produced by electrolysis of potassium chloride. About 180,000 tons of KOH (90% basis) were produced in the United States in 1969.[1929] Its uses are:

(1) in the manufacture of "soft" soap;

(2) in producing other potassium compounds and organic syntheses;

(3) in electroplating, photoengraving and lithography;

(4) as a chemical reagent;

(5) as a mordant for wood;

(6) as a paint and varnish remover;

(7) in mercerizing cotton.

Potassium Oxalate. Potassium oxalate, $K_2C_2O_4 \cdot H_2O$, is a colorless, odorless, monoclinic crystal, efflorescent in warm, dry air. Its uses are:

(1) in cleaning and bleaching straw

(2) in removing stains in photography;

(3) in examination of blood to prevent its coagulation;

(4) as a reagent in analytical chemistry.

Sodium Amide. Sodium amide, $NaNH_2$, also known as sodamide, is a white to olive-green solid with seashell fracture. It reacts violently with water to form sodium hydroxide and ammonia. It is produced by reacting ammonia gas with molten sodium or liquid ammonia with sodium in presence of ferric nitrate as a catalyst. Its uses are:

(1) as a dehydrating agent;

(2) in the production of indigo, sodium azide, and hydrazine;

(3) as an intermediate in the preparation of sodium cyanide;

(4) in ammonolysis, Claisen condensation, alkylation of nitriles and ketones;

(5) in the synthesis of ethynyl compounds, acetylenic carbinols.

Sodium Hydride. Sodium hydride, NaH, is a silvery needle. The commercial product is a gray-white powder. It reacts explosively with water. It is prepared by passing hydrogen gas into molten sodium dispersed in oil or mixed with a catalyst such as anthracene at a temperature above 250 C. Its uses are:

(1) in the reduction of oxide scale of metals (sodium hydride used is in solution with molten sodium hydroxide);

(2) as a reducing agent and reduction catalyst in high temperatures.

Sodium Hydrosulfite. Sodium hydrosulfite, $Na_2S_2O_4$, is a white or grayish-white crystalline powder, with a slight characteristic odor. It oxidizes in air (more readily so in the presence of moisture or when in solution) to bisulfite and bisulfate. It is prepared by the reduction of sodium sulfite, sodium bisulfite, or sulfur dioxide with a reducing agent such as iron or zinc powder, sodium or zinc amalgam or sodium suspension.

The U.S. production of sodium hydrosulfite amounted to about 74 million pounds in 1967. Its applications are based mainly on its powerful reducing action. The main uses are:

(1) as a reducing agent, particularly in dyeing of textiles with indigo and vat dyes;

(2) in bleaching soaps, straw, ground wood pulp, sugar, molasses and glues.

Sodium Oxalate. Sodium oxalate, $Na_2C_2O_4$, is a colorless, odorless crystal or powder. It is used in finishing textiles, tanning and finishing leather and for standardizing potassium permanganate solution used in analytical chemistry.

Sodium Sulfide. Sodium sulfide, $Na_2S \cdot 9H_2O$, is a colorless, tetragonal, deliquescent crystal, with the odor of hydrogen sulfide. Exposure of the crystals to air produces the toxic hydrogen sulfide. Industrially, it may be prepared by (1) heating sodium sulfate with coal, or (2) reacting hydrogen sulfide with sodium hydroxide according to the following equations:

$$H_2S + NaOH \longrightarrow NaHS + H_2O$$

$$NaHS + NaOH \longrightarrow Na_2S + H_2O$$

Estimated U.S. production of sodium sulfide in 1965 was 46,000 tons (as 60 to 62 percent solution). Its uses are:

(1) in dehairing hides (in leather industry), and wool pulling;

(2) as a reducing agent in the production of amino compounds;

(3) in desulfurizing viscose rayon;

(4) in the manufacture of sulfur dyes and rubber;

(5) as a raw material or intermediate for the preparation of other compounds such as sodium hydrosulfide and polysulfides;

(6) in ore flotation, metal refining, engraving and lithography, cotton printing;

(7) as a chemical reagent.

Sodium Thiocyanate. Sodium thiocyanate, NaSCN, is a colorless, rhombic deliquescent crystal. It is prepared by fusing sodium cyanide solid or boiling a solution of sodium cyanide with sulfur or a polysulfide.

$$\mathrm{NaCn + S \longrightarrow NaCNS}$$

$$\mathrm{4NaCN + Na_2S_5 \longrightarrow 4NaCNS + Na_2S}$$

Its uses are:

(1) in the manufacture of other thiocyanates, especially organic;

(2) as a drying agent for wool;

(3) as a stabilizing agent in photography.

Stannic Chloride. Stannic chloride, $SnCl_4$, is a colorless, fuming, caustic liquid. It is prepared by the direct chlorination of tin which can be in molten state or finely divided suspension in stannic chloride. Its uses are:

(1) as a mordant;

(2) in dyeing of fabrics, weighing silk, tinning vessels;

(3) as a dehydrating agent in organic syntheses;

(4) reviving colors.

Thiocyanates. Inorganic thiocyanates are, in general, deliquescent crystals which are freely soluble in water and alcohol. Some would decompose on heating. They find some applications in photography, textile industry, and pyrotechnic. Some also find medical uses because they possess antithyroid properties.

## Sources and Types of Wastes

The wastes from the materials discussed in this report come from a variety of sources. They include the manufacturers of these chemicals and various industrial plants which use these chemicals in their processes or operations. The wastes are generally of the concentrated type in the form of unused or contaminated materials. For the majority of materials in this group, there is normally no dilute aqueous waste because they decompose very readily on contact with water.

## Physical and Chemical Properties

The physical and chemical properties of these inorganic materials are given in the attached worksheets.

## 2. TOXICITY[0766, 1492]

The toxicity of these materials varies from irritating and corrosive to the skin and mucous membranes to highly toxic.

Ammonium sulfide is stable only at temperatures below -18C. At higher temperatures it decomposes into ammonia and ammonium hydrosulfide ($NH_4HS$). The latter also decomposes easily at room temperatures to yield ammonia and hydrogen sulfide which is highly toxic. Consequently, under normal conditions, ammonium sulfide is irritating to the skin and emits highly toxic fumes.

Antimony pentachloride decomposes easily at room temperatures to produce chlorine gas which is highly toxic. When heated to decomposition, it emits the toxic fumes of antimony and hydrochloric acid. It will also react with water or steam to produce toxic or corrosive fumes. Antimony trichloride is poisonous and irritating to the skin. In general, antimony and its compounds can cause dermatitis, keratitis, conjunctivitis and nasal septal ulceration by contact with fumes or dust.

Calcium carbide itself is nontoxic. However, it generates acetylene on contact with water. When inhaled, acetylene is toxic.

Similarly, calcium hydride is basically nontoxic. Again, it reacts readily with water to yield hydrogen gas and calcium hydroxide.

Lithium aluminum hydride is generally not considered a toxic material. A large dose of lithium compounds has caused dizziness and prostration.

Potassium and sodium oxalate and potassium binoxalate are all toxic substances. In general, they are corrosive and produce local irritation. When ingested, they are readily absorbed from the gastro-intestinal tract and can cause severe damage to the kidneys.

Potassium hydroxide is a strong alkali. It is very caustic and corrosive to the body tissue. Ingestion may produce violent pain in the throat and epigastrium, hematemesis, and collapse. If not immediately fatal, stricture of esophagus may develop. Dilute acetic acid may be used as an antidote.

On contact with water or moist air, sodium amide and sodium hydride hydrolyze readily to yield sodium hydroxide and ammonia (from sodamide) or hydrogen (from the hydride). Sodium hydroxide is a strong alkali having the same corrosive and toxic effects as that of potassium hydroxide described in the previous paragraph. Inhalation of ammonia gas would cause edema of the respiratory tract, spasm of glottis, and asphyxia.

The toxic effects of sodium hydrosulfite are similar to those of sulfites. Fairly large doses of sulfites can be tolerated by the human body because they are readily oxidized to sulfates. However, if swallowed, the sulfites may cause irritation of the stomach by liberating free sulfurous acid.

Sodium sulfide is similar to alkali in action. It causes softening and irritation of the skin. If taken by mouth, it is corrosive and irritant through the liberation of free alkali and hydrogen sulfide. Also, exposure of the sodium sulfide crystals to moist air would produce hydrogen sulfide which is highly toxic.

Thiocyanates, including sodium thiocyanate, are not normally dissociated into cyanide. They have a low acute toxicity. Prolonged absorption of thiocyanates may cause various skin eruptions, coryza, occasional dizziness, cramps and convulsions, nausea, vomiting, and mild to severe disturbances of the nervous system.

Stannic chloride may be highly irritating to the mucous membranes of the eyes and the respiratory tract. More severe exposures may result in pulmonary edema and often laryngeal spasm.

The Threshold Limit Value (TLV) recommended by the American Conference of Governmental Industrial Hygienists and lethal doses reported for the materials in this report are tabulated as follows:[0225, 1312]

| Chemicals | TLV | Lethal Dose |
|---|---|---|
| Ammonium Sulfide | -- | or $LD_{Ca}$: 2 mg/kg, mouse |
| Antimony Pentachloride | 0.5 mg as $Sb/M^3$ | -- |
| Antimony Trichloride | 0.5 mg as $Sb/M^3$ | or $LD_{50}$: 675 mg/kg, rat |
| Calcium Carbide | -- | -- |
| Calcium Hydride | -- | -- |
| Lithium Aluminum Hydride | -- | -- |
| Potassium Binoxalate | -- | -- |
| Potassium Hydroxide | -- | or $LD_{50}$: 1230 mg/kg, rat |
| Potassium Oxalate | -- | -- |
| Sodium Amide | -- | -- |
| Sodium Hydride | -- | -- |
| Sodium Hydrosulfite | -- | -- |
| Sodium Oxalate | -- | sc $LD_{Ca}$: 100 mg/kg, mouse |
| Sodium Sulfide | -- | ip $LD_{50}$: 53 mg/kg, mouse |
| Sodium Thiocyanate | -- | or $LD_{50}$: 764 mg/kg, rat |
| Stannic Chloride | 2 $mg/M^3$ | ip $LD_{50}$: 2/mg/kg, mouse |
| Thiocyanate | -- | -- |

## 3. OTHER HAZARDS

The hydrides (sodium, calcium, and lithium aluminum) react violently with water to generate hydrogen gas. Similarly, calcium carbide reacts very rapidly with water to yield acetylene. Both hydrogen and acetylene are highly flammable. They can cause fire and explosion hazards.

Ammonium sulfide is unstable at room temperatures. It decomposes readily to yield hydrogen sulfide. On contact with water or moisture in the air, sodium sulfide also decomposes easily to generate hydrogen sulfide. The hydrogen sulfide evolved can cause a fire hazard or form an explosive mixture with air.

## 4. DEFINITION OF ADEQUATE WASTE MANAGEMENT

### Handling, Storage, and Transportation

Most of the materials in this group react rapidly with water or moisture in air, producing either flammable or toxic vapors. Therefore, they must be kept tightly closed in dry and cool areas with adequate ventilation. In general, they should not be handled with bare hands. Some also decompose readily upon heating and should be kept away from heat or flame. Toxic substances such as the oxalates should be stored away from food and feed products. In shipping, sodium amide, sodium hydride and sodium hydrosulfite are shipped under the yellow label, indicating flammable solids.

### Disposal/Reuse

The chemicals discussed in this report are either so reactive with water or unstable with respect to heat that it is normally impractical to attempt to recover them for reuse with the possible exceptions of antimony and stannic chlorides. For the safe disposal of these materials, the recommended maximum exposure limit in air and in water are given as follows.

| Contaminant in Air | Provisional Exposure Limit | Basis for Recommendation |
|---|---|---|
| Antimony Pentachloride | 0.005 mg as $Sb/M^3/24$ hr | 0.01 TLV |
| Antimony Trichloride | 0.05 mg as $Sb/M^3/24$ hr | 0.01 TLV |
| Stannic Chloride | 0.02 mg as $Sb/M^3/24$ hr | 0.01 TLV |

The maximum exposure limit for the remaining materials in this group is undefined because no TLV's are available.

| Contaminant in Water | Provisional Exposure Limit Man | Provisional Exposure Limit Fish | Basis for Recommendation |
|---|---|---|---|
| Ammonium Sulfide | -- | 10 mg/l | * |
| Antimony Pentachloride | 0.5 mg(Sb)/l | 0.05 mg(Sb)/l | CTS |
| Antimony Trichloride | -- | 0.5 mg(SB)/l | CTS |
| Potassium Hydroxide | -- | 5.0 mg/l | * |
| Sodium Hydrosulfite | -- | 0.05 mg/l | * |
| Sodium Oxalate | -- | 135 mg/l | * |
| Sodium Sulfide | -- | 0.2 mg/l | * |
| Stannic Chloride | 0.05 mg (Sn)/l | 0.05 mg(Sn)/l | CTS |

The maximum exposure limit in water for the remaining materials in this group is undefined because no toxic data are available.

---

*Computed value based on critical toxicity concentration for fish. CTS computed value based on chronic toxicity drinking water studies.

## 5. EVALUATION OF WASTE DISPOSAL PROCESSES

### Option No. 1 - Hydrolysis and Combustion

Calcium carbide and the hydrides of calcium, sodium, and lithium aluminum all hydrolyze very readily producing combustible gases. For the disposal of the calcium carbide waste, the material is slowly added to a large container of water. The acetylene gas liberated is burned off with a pilot flame. The remaining residue is lime and can be sent to landfill. For the hydrides, the waste materials may be first mixed with dry sand to minimize the fire hazard before they are added to water. Again, the hydrogen gas liberated is burned off with a pilot flame. The remaining residues are hydroxides and they should be neutralized by an acid before being disposed of.

### Option No. 2 - Hydrolysis and Neutralization

Sodium amide hydrolyzes rapidly to form sodium hydroxide and ammonia, both of which can be neutralized by hydrochloric or sulfuric acid. The neutral solution can be safely discharged if the salt content is below the limits set to maintain water quality. Salt mixtures containing antimony chlorides or stannous chlorides will form the very slightly soluble oxides of these metals when dissolved in water and neutralized. Removal of the oxides is followed by sulfide precipitation described below to ensure removal of the metal ions from solution. The antimony oxides can be sent to a refiner if justified by market conditions or placed in drums and stored at a National Disposal Site. The tin oxides can be refined or landfilled.

### Option No. 3 - Sulfide Precipitation

The soluble sodium and ammonium sulfides can be converted into the insoluble ferrous sulfide by reaction with ferrous chloride solution. The ferrous sulfide precipitate may be removed by filtration and reclaimed. Similarly, antimony pentachloride and trichloride can be converted to the corresponding insoluble sulfides by saturating the chloride solutions with hydrogen sulfide. After filtering out the sulfide precipitate, the filtrate solution is neutralized with soda ash and then discharged. The recovered sulfide may be sent to refiners for reprocessing if economically feasible or placed in containers and shipped to a National Disposal Site for storage.

## Option No. 4 - Oxidation

When ignited, potassium binoxalate and oxalate and sodium oxalate are converted into carbonates. The carbonates, particularly sodium carbonate, have many applications. Since they are nontoxic, they may also be sent to landfill or simply sewered.

Sodium hydrosulfite is a reducing agent. It can be easily oxidized to yield sodium sulfate with the liberation of sulfur dioxide. The exhaust gas is therefore scrubbed with an aqueous suspension of finely-ground limestone to absorb the sulfur dioxide gas. The soluble sodium sulfate is also converted to the insoluble calcium sulfate which is removed by filtration and sent to landfill. The filtrate is diluted and discharged.

## Option No. 5 - Neutralization

Disposal of contaminated potassium hydroxide (solid) can be carried out by first dissolving it in water followed by neutralization with an acid and finally sewered. Similarly, sodium thiocyanate which has a low acute toxicity can be disposed of by dissolving it in a large quantity of water, buffered with slight excess of soda ash and finally neutralized by an acid and sewered.[0095]

In summary, the majority of materials in this group can be easily disposed of by reacting with water or by ignition or by neutralization. These procedures are all simple and seem to be quite adequate.

## 6. APPLICABILITY TO NATIONAL DISPOSAL SITE

The disposal processing described herein is of a level that is quite easily performed adequately in an industrial environment. Most of the treated materials which cannot be economically recovered can be discharged to sewer systems or landfilled. An exception is the stable antimony product, either the oxide or sulfide, which should be stored at a National Disposal Site rather than landfilled due to the possibility of toxic contamination of waters surrounding a landfill site.

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29

HAZARDOUS WASTES PROPERTIES
WORKSHEET

H. M. Name Ammonium Sulfide

IUC Name

Common Names

Structural Formula

$(NH_4)_2S$

Molecular Wt. 68.14(1)  Melting Pt. decomposes (1)  Boiling Pt.

Density (Condensed) @  Density (gas) @

Vapor Pressure (recommended 55 C and 20 C)

@  @  @

Flash Point  Autoignition Temp.

Flammability Limits in Air (wt %)  Lower  Upper

Explosive Limits in Air (wt. %)  Lower  Upper

Solubility

Cold Water Very soluble  Hot Water decomposes  Ethanol soluble

Others: very soluble in $NH_3$

Acid, Base Properties

Highly Reactive with

Compatible with

Shipped in

ICC Classification  Coast Guard Classification

Comments

References (1) 1570

## HAZARDOUS WASTES PROPERTIES WORKSHEET

35

H. M. Name Antimony Petachloride

IUC Name

Common Names

Structural Formula

$SbCl_5$

Molecular Wt. 299.02 (1) Melting Pt. 2.8 C (1) Boiling Pt. 140 C (2)

Density (Condensed) liq. 2.336 @ 20 C Density (gas) @

Vapor Pressure (recommended 55 C and 20 C) (2)

1 mm Hg @ 22.7 C @ @

Flash Point Autoignition Temp.

Flammability Limits in Air (wt %) Lower Upper

Explosive Limits in Air (wt. %) Lower Upper

Solubility (1)

Cold Water decomposes Hot Water decomposes Ethanol

Others: soluble in HCl, tarta, $CHCl_3$

Acid, Base Properties

Highly Reactive with

Compatible with

Shipped in

ICC Classification (2) corrosive liquid, white label Coast Guard Classification (2) corrosive liquid, white label

Comments

References (1) 1570
(2) 0766

## HAZARDOUS WASTES PROPERTIES WORKSHEET

41

H. M. Name Antimony Trichloride

IUC Name ______

Common Names ______

Structural Formula

$SbCl_3$

Molecular Wt. 228.11 (1)   Melting Pt. 73.4 C (1)   Boiling Pt. 283 C (1)

Density (Condensed) 3.14 @ 25 C   Density (gas) ______ @ ______

Vapor Pressure (recommended 55 C and 20 C) (2)

1 mm Hg @ 49.2 C   ______ @ ______   ______ @ ______

Flash Point ______   Autoignition Temp. ______

Flammability Limits in Air (wt %)   Lower ______   Upper ______

Explosive Limits in Air (wt. %)   Lower ______   Upper ______

Solubility (1)

Cold Water 601.6 grams/100 ml @ 0C   Hot Water - at 80 C   Ethanol soluble

Others: soluble in HCl, $CHCl_3$, benzene, acetone

Acid, Base Properties ______

Highly Reactive with ______

Compatible with ______

Shipped in ______

ICC Classification ______   Coast Guard Classification ______

Comments ______

References (1) 1570
(2) 0766

## HAZARDOUS WASTES PROPERTIES
## WORKSHEET

89

H. M. Name Calcium Carbide

IUC Name ____

Common Names ____

Structural Formula

$CaC_2$

Molecular Wt. 64.10(1)

Melting Pt. Stable 25-477 C(1)

Boiling Pt. 2300 C(1)

Density (Condensed) 2.22 @ ____ ____

Density (gas) ____ @ ____ ____

Vapor Pressure (recommended 55 C and 20 C)

____ @ ____ ____ @ ____ ____ @ ____

Flash Point ____

Autoignition Temp. ____

Flammability Limits in Air (wt %) Lower ____ Upper ____

Explosive Limits in Air (wt. %) Lower ____ Upper ____

Solubility (1)

Cold Water decomposes

Hot Water decomposes

Ethanol ____

Others: ____

Acid, Base Properties ____

Highly Reactive with water

Compatible with ____

Shipped in ____

ICC Classification ____

Coast Guard Classification (2)hazardous artic

Comments ____

References (1) 1570
(2) 0766

93

## HAZARDOUS WASTES PROPERTIES WORKSHEET

H. M. Name Calcium Hydride

IUC Name

Common Names

Structural Formula

$CaH_2$

Molecular Wt. 42.10(1)    Melting Pt. decomposes(1) Ca 600 C    Boiling Pt.

Density (Condensed) 1.9 @    Density (gas) @

Vapor Pressure (recommended 55 C and 20 C)

@    @    @

Flash Point    Autoignition Temp.

Flammability Limits in Air (wt %)    Lower    Upper

Explosive Limits in Air (wt. %)    Lower    Upper

Solubility (1)

Cold Water decomposes    Hot Water    Ethanol decomposes

Others:

Acid, Base Properties

Highly Reactive with (2) water, lower alcohols and carboxylic acids

Compatible with

Shipped in

ICC Classification    Coast Guard Classification

Comments

References (1) 1570
(2) 1492

## HAZARDOUS WASTES PROPERTIES
## WORKSHEET

244

H. M. Name Lithium Aluminum Hydride

IUC Name

Common Names

Structural Formula

$LiAlH_4$

Molecular Wt. 37.95(1)    Melting Pt. decomposes(1) @ 125 C    Boiling Pt.

Density (Condensed) @    Density (gas) @

Vapor Pressure (recommended 55 C and 20 C)

@    @    @

Flash Point    Autoignition Temp.

Flammability Limits in Air (wt %)    Lower    Upper

Explosive Limits in Air (wt. %)    Lower    Upper

Solubility (1)

Cold Water decomposes    Hot Water    Ethanol slightly soluble

Others: slightly soluble in liquid $NH_3$

Acid, Base Properties

Highly Reactive with(2) water and alcohols

Compatible with

Shipped in

ICC Classification    Coast Guard Classification

Comments

References (1) 1570
(2) 1492

342

## HAZARDOUS WASTES PROPERTIES
## WORKSHEET

H. M. Name Potassium Binoxalate

IUC Name

Common Names

Structural Formula

$KHC_2O_4$

Molecular Wt. 128.11(1) Melting Pt. decomposes (1) Boiling Pt.

Density (Condensed) 2.044 @ Density (gas) @

Vapor Pressure (recommended 55 C and 20 C)

@ @ @

Flash Point Autoignition Temp.

Flammability Limits in Air (wt %) Lower Upper

Explosive Limits in Air (wt. %) Lower Upper

Solubility (1)

Cold Water 2.5 grams/100 ml Hot Water 16.7 grams/100 ml @ 100C Ethanol insoluble

Others:

Acid, Base Properties

Highly Reactive with

Compatible with

Shipped in

ICC Classification Coast Guard Classification

Comments

References (1) 1570

## HAZARDOUS WASTES PROPERTIES WORKSHEET

347

H. M. Name Potassium Hydroxidw

IUC Name

Common Names

Structural Formula

KOH (S)

Molecular Wt. 56.11[(1)] Melting Pt. 360.4 ± 0.7 C Boiling Pt. 1320-1324 C[(1)]

Density (Condensed) 2.044 @ Density (gas) @

Vapor Pressure (recommended 55 C and 20 C)

@ @ @

Flash Point Autoignition Temp.

Flammability Limits in Air (wt %) Lower Upper

Explosive Limits in Air (wt. %) Lower Upper

Solubility (1)

Cold Water 107 g/100 ml @ 15 C Hot Water 178 g/100 ml @ 100 C Ethanol very soluble

Others:

Acid, Base Properties caustic

Highly Reactive with

Compatible with

Shipped in

ICC Classification Coast Guard Classification (2) Hazardous article

Comments

References (1) 1570
(2) 0766

348

## HAZARDOUS WASTES PROPERTIES
## WORKSHEET

H. M. Name Potassium Oxalate

IUC Name

Common Names

Structural Formula

$K_2C_2O_4 \cdot H_2O$

Molecular Wt. 184.24(1) Melting Pt. $-H_2O$ @ 100 C(1) Boiling Pt.

Density (Condensed) 2.127 @ Density (gas) @

Vapor Pressure (recommended 55 C and 20 C)

@ @ @

Flash Point Autoignition Temp.

Flammability Limits in Air (wt %) Lower Upper

Explosive Limits in Air (wt. %) Lower Upper

Solubility(1)

Cold Water Hot Water 33 g/100 ml @ 16 C Ethanol

Others:

Acid, Base Properties

Highly Reactive with

Compatible with

Shipped in

ICC Classification Coast Guard Classification

Comments

References (1) 1570

375

## HAZARDOUS WASTES PROPERTIES
## WORKSHEET

H. M. Name Sodium Amide

IUC Name

Common Names

Structural Formula

$NaNH_2$

Molecular Wt. 39.01 (1)

Melting Pt. 210 C (1)

Boiling Pt. 400 C (1)

Density (Condensed) @

Density (gas) @

Vapor Pressure (recommended 55 C and 20 C)

@

@

@

Flash Point

Autoignition Temp.

Flammability Limits in Air (wt %) Lower Upper

Explosive Limits in Air (wt. %) Lower Upper

Solubility (1)

Cold Water decomposes

Hot Water decomposes

Ethanol decomposes, hot

Others:

Acid, Base Properties

Highly Reactive with water

Compatible with

Shipped in

ICC Classification (2) flammable solid, yellow label

Coast Guard Classification (2) inflammable solid, yellow label

Comments

References (1) 1570

(2) 0766

391

## HAZARDOUS WASTES PROPERTIES WORKSHEET

H. M. Name Sodium Hydride

IUC Name

Common Names

Structural Formula

NaH

Molecular Wt. 24.0 (1)

Melting Pt. decomposes @ 800 C (1)

Boiling Pt.

Density (Condensed) 0.92 @

Density (gas) @

Vapor Pressure (recommended 55 C and 20 C)

@ @ @

Flash Point

Autoignition Temp.

Flammability Limits in Air (wt %) Lower Upper

Explosive Limits in Air (wt. %) Lower Upper

**Solubility** (1)

Cold Water decomposes

Hot Water decomposes

Ethanol

Others: soluble in molten sodium

Acid, Base Properties

Highly Reactive with (3) water and lower alcohols

Compatible with

Shipped in

ICC Classification (2) flammable solid, yellow label

Coast Guard Classification (2) inflammable solid, yellow label

Comments

References (1) 1570

(2) 0766

(3) 1492

392

## HAZARDOUS WASTES PROPERTIES
## WORKSHEET

H. M. Name Sodium Hydrosulfite

IUC Name

Common Names

Structural Formula

$Na_2S_2O_4$

Molecular Wt. 174.13(1) Melting Pt. decomposes (2) Boiling Pt.

Density (Condensed) @ Density (gas) @

Vapor Pressure (recommended 55 C and 20 C)

@ @ @

Flash Point Autoignition Temp.

Flammability Limits in Air (wt %) Lower Upper

Explosive Limits in Air (wt. %) Lower Upper

Solubility (1)

Cold Water very soluble Hot Water decomposes(2) Ethanol slightly

Others:

Acid, Base Properties

Highly Reactive with

Compatible with

Shipped in

ICC Classification (3) flammable solid, yellow yellow label Coast Guard Classification (3)inflammable soli yellow label

Comments

References (1) 1492
(2) 1433
(3) 0766

398

## HAZARDOUS WASTES PROPERTIES WORKSHEET

H. M. Name Sodium Oxalate

IUC Name ____

Common Names ____

Structural Formula

$Na_2C_2O_4$

Molecular Wt. 134.0[(1)] Melting Pt. decomposes 250-270 C (1) Boiling Pt. ____

Density (Condensed) 2.34 @ ____ ____ Density (gas) ____ @ ____ ____

Vapor Pressure (recommended 55 C and 20 C)

____ @ ____ ____ @ ____ ____ @ ____

Flash Point ____ Autoignition Temp. ____

Flammability Limits in Air (wt %) Lower ____ Upper ____

Explosive Limits in Air (wt. %) Lower ____ Upper ____

Solubility (1)

Cold Water 3.7 g/100 ml @ 20 C Hot Water 6.33 g/100 ml @ 100 C Ethanol insoluble

Others: ____

Acid, Base Properties ____

Highly Reactive with ____

Compatible with ____

Shipped in ____

ICC Classification ____ Coast Guard Classification ____

Comments ____

References (1) 1570

404

## HAZARDOUS WASTES PROPERTIES
## WORKSHEET

H. M. Name Sodium Sulfide

IUC Name

Common Names

Structural Formula

$Na_2S \cdot 9H_2O$

Molecular Wt. 240.18(1) Melting Pt. decomposes at 920 C (1) Boiling Pt.

Density (Condensed) 1.427 @ Density (gas) @

Vapor Pressure (recommended 55 C and 20 C)

@ @ @

Flash Point Autoignition Temp.

Flammability Limits in Air (wt %) Lower Upper

Explosive Limits in Air (wt. %) Lower Upper

Solubility (1)

Cold Water 47.5 g/100 ml @ 10 C Hot Water 96.7 g/100 ml @ 100 C Ethanol slightly solubl

Others:

Acid, Base Properties

Highly Reactive with

Compatible with

Shipped in

ICC Classification Coast Guard Classification

Comments

References (1) 1570

## HAZARDOUS WASTES PROPERTIES
## WORKSHEET

406

H. M. Name Sodium Thiocyanate

IUC Name

Common Names

Structural Formula

NaSCN

Molecular Wt. 81.07 (1)

Melting Pt. 287 C (1)

Boiling Pt.

Density (Condensed) @

Density (gas) @

Vapor Pressure (recommended 55 C and 20 C)

@

@

@

Flash Point

Autoignition Temp.

Flammability Limits in Air (wt %) Lower Upper

Explosive Limits in Air (wt. %) Lower Upper

Solubility

Cold Water 139.31 g/100 ml @ 21.3C

Hot Water 225 g/100 ml @ 100 C

Ethanol very soluble

Others: very soluble in acetone

Acid, Base Properties

Highly Reactive with

Compatible with

Shipped in

ICC Classification

Coast Guard Classification

Comments

References (1) 1570

408

## HAZARDOUS WASTES PROPERTIES WORKSHEET

H. M. Name Staunic Chloride

IUC Name

Common Names

Structural Formula

$SnCl_4$

Molecular Wt. 260.50 (1) Melting Pt. -33 C (1) Boiling Pt. 114.1 C (1)

Density (Condensed) @ Density (gas) @

Vapor Pressure (recommended 55 C and 20 C) (2)

10 mm Hg @ 10 C @ @

Flash Point Autoignition Temp.

Flammability Limits in Air (wt %) Lower Upper

Explosive Limits in Air (wt. %) Lower Upper

Solubility (1)

Cold Water soluble Hot Water decomposes Ethanol

Others: soluble in ether

Acid, Base Properties

Highly Reactive with

Compatible with

Shipped in

ICC Classification Coast Guard Classification

Comments

References (1) 1570
(2) 0766

# PROFILE REPORT ON
# ESTERS

Amyl Acetate (30), Butyl Acetate (72), Butyl Acrylate (73), Di-*n*-butyl Phthalate (139), Ethyl Acetate (175), Ethyl Acrylate (176), Ethyl Phthalate (194), Isobutyl Acetate (224), Isopropyl Acetate (229), Methyl Acetate (262), Methyl Acrylate (263), Methyl Formate (270), Methyl Methacrylate (273), *n*-Propyl Acetate (357), Vinyl Acetate (449).

## 1. GENERAL

### Introduction

The esters treated in this report have all been selected as probable candidates for municipal disposal. These materials are similar in that most are commodity chemicals with relatively low toxicity, well-defined and safe methods of industrial handling and common methods of disposal. The esters are, therefore, discussed as a class in this report.

### Manufacture

The most common method of ester formation is the direct reaction of a carboxylic acid with an alcohol. The addition of an acid catalyst such as *p*-toluenesulfonic acid, sulfuric acid or hydrogen chloride speeds the approach to equilibrium. Many procedures are used to disturb this equilibrium and force the reaction to completion. These involve the removal of one or more reactants or products by simple or complex distillation, azeotrope formation,and removal of water by desiccation or chemical means.

Acrylic acid and the acrylates have a tendency to polymerize in the presence of acid and for this reason, most acrylates are made by other methods. The most widely used method is the reaction of carbon monoxide, acetylene and an alcohol in the presence of a nickel catalyst.

Vinyl acetate is produced by the reaction of acetic acid with acetylene.

### Uses[1433,1506]

Solvents and plasticizers. The greatest uses of esters are as solvents and plasticizers. The lower esters are used in the lacquer, paint, and varnish fields, and the higher ones are used primarily as plasticizers.

Resins, plastics and coatings. Many polymeric materials in commercial use are based on esters. These include vinyl polymers made from such unsaturated esters as the acrylates, methacrylates, vinyl acetate and their homologs; alkyd resins which are essentially crosslinked polyesters prepared from polyhydric alcohols and dibasic acids, and the polyester resins and plastics.

Lubricants. Esters, in the form of natural fats, oils and waxes have been used as lubricants since ancient times. Animal and vegetable fats and oils have largely been supplanted by petroleum hydrocarbons and multiviscosity based on the acrylates and isobutylene.

Perfumes, flavors, cosmetics and soap. Compared with the volume of esters used in solvents and plasticizers, the tonnage of esters used in improving odors and flavors is small, but nevertheless important economically and aesthetically.

Medicinals. Although the ester group itself is relatively inert physiologically, esters are used widely in pharmaceuticals. In general, esterification of a physiologically active alcohol or phenol with an aliphatic acid detoxifies it by decreasing the concentration of active compound present. The active compound is released gradually in the body by hydrolysis of the ester. An example of detoxification is acetylation of salicylic acid to give acetylsalicylic acid, the sodium salt of which is the common analgesic aspirin.

## 2. TOXICOLOGY[0766]

The esters treated in this report are relatively non-toxic. They act mainly as irritants to the mucous membranes, particularly the eyes, gums and respiratory passages. Prolonged contact or repeated exposure can cause conjunctival irritation and corneal clouding. They are also mildly narcotic, the principal symptoms being headache, fatigue, drowsiness and oppression in the chest. Death is extremely rare. The methyl esters are greater irritants than the higher homologues, while the opposite is true for the narcotic effects. The acrylates are considered to be more toxic than the acetate, formate and phthalate esters.

Chronic poisoning has not been fully investigated,but in the case of ethyl acetate, it can produce secondary anemia, leucocystosis and cloudy swelling,and fatty degeneration of the viscera.

The Threshold Limit Values (TLV) and Maximum Allowable Concentrations (MAC) that have been established are:

| Substance | TLV ppm | TLV mg/M$^3$ | MAC ppm |
|---|---|---|---|
| Amyl acetate | 100 | 525 | 100 |
| Butyl acetate | 150 | 710 | 200 |
| Butyl acrylate | | | |
| Di-n-butyl phthalate | | 5 | |
| Ethyl acetate | 400 | 1400 | 400 |
| Ethyl acrylate | 25 | 100 | 25 |
| Ethyl phthalate | | | |
| Isobutyl acetate | 150 | 700 | |
| Isopropyl acetate | 250 | 950 | |
| Methyl acetate | 200 | 610 | 200 |
| Methyl acrylate | 10 | 35 | |
| Methyl formate | 100 | 250 | |
| Methyl methacrylate | 100 | 410 | |
| n-Propyl acetate | 200 | 840 | |
| Vinyl acetate | 10 | 30 | |

## 3. OTHER HAZARDS

Under the proper conditions such as the presence of oxygen or other polymerization initiator and heat, acrylate esters can polymerize violently.[0766,1433]

## 4. DEFINITION OF WASTE MANAGEMENT PRACTICES

### Handling, Storage and Transportation

The esters treated in this report are all toxic to a certain extent due to the narcotic effects of high concentrations and irritating effects of the liquids or vapors, especially in the sensitive areas of the eyes, mucous membranes and respiratory tract. Thus, they should be handled in a well-ventilated area and protective clothing and respirators are recommended where necessary. In cases of accidental contact, all contaminated clothing should be removed and the skin washed thoroughly with soap and water.

These materials are shipped under a variety of U.S. Department of Transportation, Coast Guard and IATA regulations. Most regulations relate to the flammability and corrosiveness of these compounds. Information on safe handling and use of these compounds can be found in standard reference sources or manufacturers' Technical Data Sheets.

## Disposal/Reuse

Manufacturers who use the esters as chemical intermediates or process solvents recycle as much material as possible. Material used in perfumes, flavors, cosmetics, soaps, lubricants and medicinals is consumed in small quantities by the public and not recoverable. A substantial amount of the esters in this group are used to produce plasticizers, resins, paint lattices, or plastics. This material is not recoverable.

Many of the various manufacturing processes result in dilute ester waste streams which have a high chemical and biological oxygen demand.[0285,1543] They can be treated on site or discharged into the municipal sewers.

Recommended air and water standards are listed below. The air standard is .01 TLV and the water standard is .01 TLV by weight in 2 liters of water in the absence of independent data. No standards have been recommended for compounds for which TLVs have not been established.

| Substance | Limit for Air (Man) | | Limit for Water (Man) | Limit for Water (Fish) |
|---|---|---|---|---|
| | ppm | mg/M$^3$ | ppm or mg/l | ppm or mg/l |
| Amyl Acetate | 1.0 | 5.3 | 26.3 | 6.5 |
| Butyl Acetate | 1.5 | 7.1 | 35.5 | 4.4 |
| Butyl Acrylate | | | | 10 - 100 |
| Di-n-butyl phthalate | .05 | | 0.25 | 100 - 1000 |
| Ethyl Acetate | 4.0 | 14 | 70.0 | 100 |
| Ethyl Acrylate | 0.25 | 1.0 | 5.0 | 10 - 100 |
| Ethyl Phthalate | | | | 0.12 |
| Isobutyl Acetate | 1.5 | 7.0 | 35.0 | 100 - 1000 |
| Isopropyl Acetate | 2.5 | 9.5 | 47.5 | |
| Methyl Acetate | 2.0 | 6.1 | 30.5 | 100 - 1000 |
| Methyl Acrylate | 0.1 | 0.35 | 1.8 | 10 - 100 |
| Methyl Formate | 1.0 | 2.5 | 12.5 | 10 - 100 |
| Methyl Methacrylate | 1.0 | 4.1 | 20.5 | 40 |
| n-Propyl Acetate | 2.0 | 8.4 | 42.0 | 10 - 100 |
| Vinyl Acetate | 0.1 | 0.3 | 1.5 | 2.5 |

## 5. EVALUATION OF WASTE MANAGEMENT PRACTICES

### Option No.1 - Recycling

Manufacturers that use esters as chemical intermediates or process solvents recycle as much material as possible. In addition, a certain amount of contaminated esters are eligible for reprocessing. This is the method of choice wherever possible.

### Option No.2 - Treatment of Waste Water to Reduce Chemical and Biological Oxygen Demand

The esters treated in this report not only have a very low level of toxicity but they can be biodegraded very rapidly by unacclimated activated sludges. This is due in part to the fact that after hydrolysis, the component acids and alcohols are the same as or very similar to carboxylic acids present in normal sewage. Thus, the best method of disposal is via municipal sewage treatment plants, provided the rate of discharge is uniform.

### Option No.3 - Incineration

Bulk quantities of contaminated esters that can not be reprocessed or released by controlled dilution can best be disposed of by incineration. Since this will probably be an unusual occurrence, this is best done at municipal incineration sites.

## 6. APPLICABILITY TO NATIONAL DISPOSAL SITES

All of the wastes generated by the industries that produce and use the esters treated in this report can be handled by municipal disposal either by sewage treatment or incineration. Disposal is so easy and safe that use of facilities at the National Disposal Sites should not be considered.

## 7. REFERENCES

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## HAZARDOUS WASTES PROPERTIES
## WORKSHEET

30

H. M. Name Amyl Acetate

IUC Name n-amyl acetate

Common Names pear oil

Structural Formula

$CH_3CO_2(CH_2)_4CH_3$

Molecular Wt. 130.18 Melting Pt. -78.5 C(1) Boiling Pt. 148 C/(737mm)(1)

Density (Condensed) 0.879 @ 20/20 C(1) Density (gas) 4.5(1) @

Vapor Pressure (recommended 55 C and 20 C)

@ @ @

Flash Point 77 F (C.C.)(1) Autoignition Temp. 714 F(1)

Flammability Limits in Air (wt %) Lower Upper

Explosive Limits in Air (wt. %) Lower 1.1%(1) Upper 7.5%(1)

Solubility

Cold Water insoluble(2) Hot Water Ethanol soluble(2)

Others: ethyl ether

Acid, Base Properties

Highly Reactive with

Compatible with

Shipped in

ICC Classification Flammable, red label(1) Coast Guard Classification red label(1)

Comments

References (1) 0766
(2) 1492

## HAZARDOUS WASTES PROPERTIES
## WORKSHEET

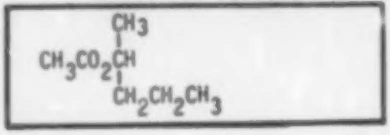
30

H. M. Name Amyl Acetate

IUC Name 2-pentyl acetate

Common Names amyl acetate

Structural Formula



$$CH_3CO_2\overset{CH_3}{\underset{CH_2CH_2CH_3}{CH}}$$

Molecular Wt. 130.1 Melting Pt. ______ Boiling Pt. 120 C(1)

Density (Condensed) 0.862-0.866@ 20/20 C(1) Density (gas) 4.48(1) @ ______ ______

Vapor Pressure (recommended 55 C and 20 C)

______ @ ______ ______ @ ______ ______ @ ______

Flash Point 89 F (C.C.)(1) Autoignition Temp. ______

Flammability Limits in Air (wt %) Lower ______ Upper ______

Explosive Limits in Air (wt. %) Lower ______ Upper ______

Solubility

Cold Water ______ Hot Water ______ Ethanol ______

Others: ethyl, ether

Acid, Base Properties ______

Highly Reactive with ______

Compatible with ______

Shipped in ______

ICC Classification ______ Coast Guard Classification ______

Comments ______

References (1) 0766

72

## HAZARDOUS WASTES PROPERTIES
## WORKSHEET

H. M. Name Butyl Acetate

IUC Name n-butyl acetate

Common Names

Structural Formula

$CH_3-CO_2(CH_2)_3CH_3$

Molecular Wt. 116.16 Melting Pt. -73.5 C(1) Boiling Pt. 126 C(1)

Density (Condensed) 0.88 @ 20/20 C(1) Density (gas) @

Vapor Pressure (recommended 55 C and 20 C)

15 mm @ 25 C(1) @ @

Flash Point 72 F(1) Autoignition Temp. 790 F(1)

Flammability Limits in Air (wt %) Lower Upper

Explosive Limits in Air (wt. %) Lower 1.7%(1) Upper 7.6%(1)

Solubility

Cold Water Hot Water soluble(2) Ethanol miscible(2)

Others: ether, hydrocarbons(2)

Acid, Base Properties

Highly Reactive with

Compatible with

Shipped in

ICC Classification Flammable, red label(1) Coast Guard Classification Inflammable(1)

Comments

References (1) 0766
(2) 1492

72

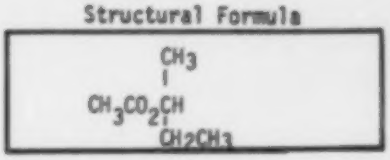
## HAZARDOUS WASTES PROPERTIES
## WORKSHEET

H. M. Name Butyl Acetate

IUC Name sec-butyl acetate

Common Names

Structural Formula



$$CH_3CO_2\underset{\mathrm{CH_2CH_3}}{\overset{\mathrm{CH_3}}{CH}}$$

Molecular Wt. 116.16 Melting Pt. Boiling Pt. 112 C(1)

Density (Condensed) 0.862-0.866 @ 20/20 C(1) Density (gas) 4.00(1) @

Vapor Pressure (recommended 55 C and 20 C)

@ @ @

Flash Point 88 F (O.C.)(1) Autoignition Temp.

Flammability Limits in Air (wt %) Lower Upper

Explosive Limits in Air (wt. %) Lower 1.7%(1) Upper

Solubility

Cold Water Hot Water slightly soluble(2) Ethanol soluble(2)

Others: ether(2)

Acid, Base Properties

Highly Reactive with

Compatible with

Shipped in

ICC Classification Coast Guard Classification

Comments n-butyl acetate and *tert*-butyl acetate can also be called butyl acetate and have similar properties.

References (1) 0766
(2) 1492

## HAZARDOUS WASTES PROPERTIES
## WORKSHEET

73

H. M. Name Butyl Acrylate

IUC Name n-butyl acrylate

Common Names

Structural Formula

$CH_2=CHCO_2-(CH_2)_3CH_3$

Molecular Wt. 128.2 Melting Pt. -64.6 C(1) Boiling Pt. 69 C/50mm(1)

Density (Condensed) 0.894 @ 25/25 C(1) Density (gas) 4.42(1) @

Vapor Pressure (recommended 55 C and 20 C)

10 mm @ 35.5 C(1) @ @

Flash Point 120 F (O.C.)(1) Autoignition Temp.

Flammability Limits in Air (wt %) Lower Upper

Explosive Limits in Air (wt. %) Lower Upper

Solubility

Cold Water Hot Water slightly soluble(2) Ethanol

Others: ether(2)

Acid, Base Properties

Highly Reactive with

Compatible with

Shipped in

ICC Classification Coast Guard Classification

Comments

References (1) 0766
(2) 1492

## HAZARDOUS WASTES PROPERTIES
## WORKSHEET

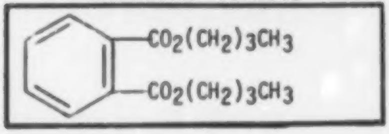
139

H. M. Name Dibutyl Phthalate

IUC Name di-n-butyl-o-phthalate

Common Names

Structural Formula



Molecular Wt. 278.3 Melting Pt. -35 C(1) Boiling Pt. 340 C(1)

Density (Condensed) 1.048 @ 20/20 C(1) Density (gas) 9.58(1) @

Vapor Pressure (recommended 55 C and 20 C)

@ @ @

Flash Point 315 F (C.C.)(1) Autoignition Temp. 757 F(1)

Flammability Limits in Air (wt %) Lower Upper

Explosive Limits in Air (wt. %) Lower Upper

Solubility

Cold Water Hot Water Ethanol

Others:

Acid, Base Properties

Highly Reactive with

Compatible with

Shipped in

ICC Classification Coast Guard Classification

Comments

References (1) 0766

## HAZARDOUS WASTES PROPERTIES
## WORKSHEET

175

H. M. Name Ethyl Acetate

IUC Name ethyl acetate

Common Names

Structural Formula

$CH_3CO_2C_2H_5$

Molecular Wt. 88.10 Melting Pt. -83.6 C(1) Boiling Pt. 77.15 C(1)

Density (Condensed) 0.8946 @ 25 C(1) Density (gas) 3.04(1) @

Vapor Pressure (recommended 55 C and 20 C)

100 mm @ 27.0 C(1) @ @

Flash Point 24 F(1) Autoignition Temp. 800 F(1)

Flammability Limits in Air (wt %) Lower Upper

Explosive Limits in Air (wt. %) Lower 2.5%(1) Upper 9%(1)

Solubility

Cold Water slightly soluble(2) Hot Water Ethanol miscible(2)

Others: acetone, chloroform, ether(2)

Acid, Base Properties

Highly Reactive with

Compatible with

Shipped in

ICC Classification Flammable, red label(1) Coast Guard Classification red label(1)

Comments Azeotropic mixture with water b.p. 70.4 C(2)

References (1) 0766

(2) 1492

176

## HAZARDOUS WASTES PROPERTIES WORKSHEET

H. M. Name Ethyl Acrylate

IUC Name ethyl acrylate

Common Names ethyl propenoate

Structural Formula

$CH_2=CHCO_2C_2H_5$

Molecular Wt. 100.11 Melting Pt. <-72 C(1) Boiling Pt. 99.8 C(1)

Density (Condensed) 0.924 @ 20/4 C(1) Density (gas) 3.45(1) @

Vapor Pressure (recommended 55 C and 20 C)

29.3 mm @ 20 C(1) @ @

Flash Point 60 F (O.C.)(1) Autoignition Temp.

Flammability Limits in Air (wt %) Lower Upper

Explosive Limits in Air (wt. %) Lower 1.8%(1) Upper

Solubility

Cold Water slightly soluble Hot Water Ethanol soluble

Others: ether

Acid, Base Properties

Highly Reactive with

Compatible with

Shipped in

ICC Classification Flammable, red label(1) Coast Guard Classification

Comments Lacrimator(2) azeotrope with water b.p. 81 C(1)

References (1) 0766

HAZARDOUS WASTES PROPERTIES
WORKS SET

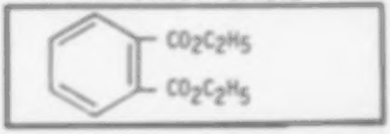
194

H. M. Name Ethyl Phthalate

IUC Name diethyl o-phthalate

Common Names

Structural Formula



Molecular Wt. 222.2 Melting Pt. -40.5 C(1) Boiling Pt. 302 C(1)

Density (Condensed) 1.110(1) @ ____ Density (gas) 7.66(1) @ ____

Vapor Pressure (recommended 55 C and 20 C)

____ @ ____ ____ @ ____ ____ @ ____

Flash Point 325 F (C.C.)(1) Autoignition Temp. ____

Flammability Limits in Air (wt %) Lower ____ Upper ____

Explosive Limits in Air (wt. %) Lower ____ Upper ____

Solubility

Cold Water insoluble(2) Hot Water ____ Ethanol miscible(2)

Others: ether(2)

Acid, Base Properties

Highly Reactive with

Compatible with

Shipped in

ICC Classification ____ Coast Guard Classification ____

Comments

References (1) 0766
(2) 1492

## HAZARDOUS WASTES PROPERTIES WORKSHEET

224

H. M. Name Isobutyl Acetate

IUC Name isobutyl acetate

Common Names

Structural Formula

$CH_3CO_2CH_2CH(CH_3)_2$

Molecular Wt. 116.10 Melting Pt. -98.9 C(1) Boiling Pt. 118.0 C(1)

Density (Condensed) 0.8685 @ 15 C(1) Density (gas) 4.0(1) @

Vapor Pressure (recommended 55 C and 20 C)

10 mm @ 12.8 C(1) @ @

Flash Point 64 F (C.C.)(1) Autoignition Temp. 793 F(1)

Flammability Limits in Air (wt %) Lower Upper

Explosive Limits in Air (wt. %) Lower Upper

Solubility

Cold Water soluble(2) Hot Water Ethanol soluble(2)

Others:

Acid, Base Properties

Highly Reactive with

Compatible with

Shipped in

ICC Classification Flammable, red label(1) Coast Guard Classification

Comments

References (1) 0766
(2) 1492

HAZARDOUS WASTES PROPERTIES
WORKSHEET

229

H. M. Name Isopropyl Acetate

IUC Name isopropyl acetate

Common Names

Structural Formula

$CH_3CO_2CH(CH_3)_2$

Molecular Wt. 102.13 Melting Pt. -73C(1) Boiling Pt. 88.4 C(1)

Density (Condensed) 0.874 @ 20/20 C(1) Density (gas) 3.52(1) @

Vapor Pressure (recommended 55 C and 20 C)

40 mm @ 17.0 C(1) @ @

Flash Point 40 F(1) Autoignition Temp. 860 F(1)

Flammability Limits in Air (wt %) Lower Upper

Explosive Limits in Air (wt. %) Lower 1.8%(1) Upper 7.8%(1)

Solubility

Cold Water Hot Water soluble(2) Ethanol soluble(2)

Others: ether(2)

Acid, Base Properties

Highly Reactive with

Compatible with

Shipped in

ICC Classification Flammable, red label(1) Coast Guard Classification

Comments

References (1) 0766
(2) 1492

## HAZARDOUS WASTES PROPERTIES
## WORKSHEET

262

H. M. Name Methyl Acetate

IUC Name methyl acetate

Common Names

Structural Formula

$CH_3CO_2CH_3$

Molecular Wt. 74.08

Melting Pt. -98.7 C(1)

Boiling Pt. 57.8 C(1)

Density (Condensed) 0.92340(1) @

Density (gas) 2.55(1) @

Vapor Pressure (recommended 55 C and 20 C)

100 mm @ 9.4 C(1)

@

@

Flash Point 14 F(1)

Autoignition Temp. 935 F(1)

Flammability Limits in Air (wt %) Lower Upper

Explosive Limits in Air (wt. %) Lower 3.1%(1) Upper 16%(1)

**Solubility**

Cold Water soluble(2)

Hot Water

Ethanol miscible(2)

Others: ether(2)

Acid, Base Properties

Highly Reactive with

Compatible with

Shipped in

ICC Classification Flammable, red label(1)

Coast Guard Classification red label(1)

Comments

References (1) 0766
(2) 1492

## HAZARDOUS WASTES PROPERTIES
## WORKSHEET

263

H. M. Name Methyl Acrylate

IUC Name mathyl acrylate

Common Names

Structural Formula

$CH_2=CHCO_2CN_3$

Molecular Wt. 86.1 Melting Pt. -75 C(1) Boiling Pt. 80 C(1)

Density (Condensed) 0.949 @ 25 C(1) Density (gas) 2.97(1) @

Vapor Pressure (recommended 55 C and 20 C)

100 mm @ 28 C(1) @ @

Flash Point 27 F (O.C.)(1) Autoignition Temp.

Flammability Limits in Air (wt %) Lower Upper

Explosive Limits in Air (wt. %) Lower 2.8%(1) Upper 25%(1)

Solubility

Cold Water soluble(2) Hot Water Ethanol

Others:

Acid, Base Properties

Highly Reactive with

Compatible with

Shipped in

ICC Classification Coast Guard Classification

Comments Lacrimator; azeotrope with water, b.p. 73 C(2)

References (1) 0766
(2) 1492

270

## HAZARDOUS WASTES PROPERTIES
## WORKSHEET

H. M. Name Methyl Formate

IUC Name methyl formate

Common Names

Structural Formula

$HCO_2CH_3$

Molecular Wt. 60.05 Melting Pt. -99.8 C(1) Boiling Pt. 32.0 C(1)

Density (Condensed) 0.98149 @ 15/4 C(1) Density (gas) 2.07(1) @

Vapor Pressure (recommended 55 C and 20 C)

400 mm @ 16.0 C(1) @ @

Flash Point -2 F(1) Autoignition Temp. 853 F(1)

Flammability Limits in Air (wt %) Lower Upper

Explosive Limits in Air (wt. %) Lower 5.9%(1) Upper 20%(1)

Solubility

Cold Water soluble(2) Hot Water Ethanol miscible(2)

Others:

Acid, Base Properties

Highly Reactive with

Compatible with

Shipped in

ICC Classification Flammable, red label(1) Coast Guard Classification red label(1)

Comments

References (1) 0766

(2) 1492

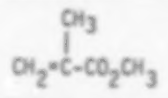
HAZARDOUS WASTES PROPERTIES
WORKSHEET

273

H. M. Name Methyl Methacrylate

IUC Name methyl 2-methylpropenoate

Structural Formula



$CH_2{=}\overset{\overset{CH_3}{|}}{C}{-}CO_2CH_3$

Common Names

Molecular Wt. 100.11 Melting Pt. -50 C(1) Boiling Pt. 101.0 C(1)

Density (Condensed) 0.936 @ 20/4 C(1) Density (gas) 3.45(1) @

Vapor Pressure (recommended 55 C and 20 C)

40 mm @ 25.5 C(1) @ @

Flash Point 50 F (O.C.)(1) Autoignition Temp.

Flammability Limits in Air (wt %) Lower Upper

Explosive Limits in Air (wt. %) Lower 2.1%(1) Upper 12.5%(1)

Solubility

Cold Water Hot Water Ethanol

Others:

Acid, Base Properties

Highly Reactive with

Compatible with

Shipped in

ICC Classification Flammable, red label(1) Coast Guard Classification

Comments

References (1) 0766

## HAZARDOUS WASTES PROPERTIES
## WORKSHEET

357

H. M. Name n-Propyl Acetate

IUC Name n-propyl acetate

Common Names

Structural Formula

$CH_3CO_2CH_2CH_2CH_3$

Molecular Wt. 102.13 Melting Pt. -92.5 C(1) Boiling Pt. 101.6 C(1)

Density (Condensed) 0.887(1) @ Density (gas) 3.52(1) @

Vapor Pressure (recommended 55 C and 20 C)

40 mm @ 28.8 C(1) @ @

Flash Point 58 F(1) Autoignition Temp. 842 F(1)

Flammability Limits in Air (wt %) Lower Upper

Explosive Limits in Air (wt. %) Lower 2.0%(1) Upper 8.0%(1)

Solubility

Cold Water slightly soluble(2) Hot Water Ethanol miscible(2)

Others: ether(2)

Acid, Base Properties

Highly Reactive with

Compatible with

Shipped in

ICC Classification Coast Guard Classification

Comments

References (1) 0766

(2) 1492

## HAZARDOUS WASTES PROPERTIES WORKSHEET

449

H. M. Name Vinyl Acetate

IUC Name vinyl acetate

Common Names

Structural Formula

$CH_3CO_2CH{=}CH_2$

Molecular Wt. 86.05 Melting Pt. -100.2 C(1) Boiling Pt. 73 C(1)

Density (Condensed) 0.9335 @ 20 C(1) Density (gas) 3.0(1) @

Vapor Pressure (recommended 55 C and 20 C)

100 mm @ 21.5 C(1) @ @

Flash Point 18 F(1) Autoignition Temp. 800 F(1)

Flammability Limits in Air (wt %) Lower Upper

Explosive Limits in Air (wt. %) Lower 2.6%(1) Upper 13.4%(1)

Solubility

Cold Water slightly soluble(2) Hot Water Ethanol miscible(2)

Others: ether(2)

Acid, Base Properties

Highly Reactive with

Compatible with

Shipped in

ICC Classification Flammable, red label(1) Coast Guard Classification red label(1)

Comments

References (1) 0766
(2) 1492

## PROFILE REPORT

## Antimony Pentasulfide (37), Antimony Sulfate (39), Antimony Trisulfide (40), Calcium Fluoride (92), Metallic Mixture of Powdered Magnesium and Aluminum (260), Silica (368), Arsenic Pentaselenide (467), Tantalum (510)

## 1. GENERAL

### Introduction

The inorganic materials to be discussed in this report have been preliminarily identified as probable candidates for industrial disposal. These materials are generally insoluble in water. Their toxicity varies from nontoxic to poisonous. Most of them are not produced in large tonnage and their industrial applications are, in general, rather limited.

### Manufacture and Uses

Antimony Pentasulfide. Antimony pentasulfide, $Sb_2S_5$, is an orange-yellow, odorless powder. It is insoluble in water. The commercial product is made by boiling antimony trisulfide with sulfur in alkaline solution and decomposing the resulting mass with hydrochloric acid to liberate the antimony pentasulfide.[1433] It may also be prepared by reacting hydrogen sulfide with hydrated antimony pentoxide suspended in water or a hydrochloric acid solution of antimony pentoxide.[2275] It is used:[1492]

(1) as a pigment in paints;

(2) in vulcanizing and coloring rubber;

(3) in the manufacture of matches and fireworks.

Antimony Sulfate. Antimony sulfate, $Sb_2(SO_4)_3$, is a colorless crystal. It deliquesces in moist air. With an excess of water, it is converted into an insoluble basic salt. It can be prepared by dissolving antimony trioxide in hot, concentrated sulfuric acid. On cooling, long, silky needles of antimony sulfate are precipitated from the solution. The precipitates are then removed by filtration, washed free of sulfuric acid with xylene, and finally dried to finished products. Antimony sulfate appears to have little commercial applications.

Antimony Trisulfide.[1433] Antimony trisulfide, $Sb_2S_3$, is a yellow-orange, amorphous solid which turns black upon standing. It is insoluble in water. It may be prepared by:

(1) reacting hydrogen sulfide with antimony trichloride;

(2) heating sulfur with antimony or antimony trioxide under vacuum conditions;

(3) reacting antimony trichloride with a sodium thiosulfate solution saturated with sulfur dioxide.

Its uses are:

(1) in the manufacture of pyrotechnics, matches and explosives;

(2) as a pigment in paints;

(3) in the manufacture of ruby glass.

Calcium Fluoride.[1433,1492] Calcium fluoride, $CaF_2$, occurs naturally in the minerals fluorite and fluorspar. The latter is a common mineral found in widely differing deposits. It is mined and purified to yield pure calcium fluoride. The U.S. consumption of fluorspar amounted to about 900,000 tons in 1964. When pure, calcium fluoride is a colorless, cubic crystal or powder. It is practically insoluble in water and becomes luminous when heated. Its uses are:

(1) as a flux in the steel industry;

(2) as a primary source of fluorine in the chemical industry;

(3) in the manufacture of glass, ceramics, enamel, portland cement, abrasives;

(4) as the light-emitting agent in most fluorescent lighting tubes;

(5) as a catalyst in dehydration and dehydrogenation processes.

Metallic Mixture of Powdered Magnesium and Aluminum.[0766,1492,1570] Magnesium is a light, silvery white and fairly tough metal. It is produced by electrolysis of fused magnesium chloride derived from brines, wells, or sea water. In fine powder, magnesium can be ignited by a spark or the flame of a match and burns with a dazzling white flame. It is unsurpassed for high intensity light effect. Therefore, it is used in flashlight photography, flares, and pyrotechnics, including incendiary bombs. Aluminum is also a light and silvery white metal. It is produced by electrolysis of alumina dissolved in a fused bath of cryolite. The finely divided aluminum powder can also be ignited easily and may cause explosions. It also is used as a flashlight in photography, and in fireworks and explosives. The mixture of magnesium and aluminum metallic powder is therefore used primarily in pyrotechnics.

Silica.[1433,1492] Silica, $SiO_2$, occurs plentifully in nature as sand, quartz, flint, chalcedony, opal, agate, and infusorial earth. It exists in a variety of polymorphic crystalline and amorphous forms as well as a liquid. Among the crystalline forms of silica are quartz, tridymite, and cristobalite in atmospheric pressure and keatite, coesite and stishorite in high pressures. Each of these in turn has its polymorphic forms existing in different temperature ranges. Among the amorphous forms of silica are silica gel, colloidal silica, precipitated silica and fused silica. Its uses are:

(1) in the manufacture of glass, ceramics, enamels, refractories, abrasives, concrete, bricks, and building stones;

(2) as a desiccant, an adsorbent, or a catalyst;

(3) in the manufacture of water glass and soluble silicates, silicon and its alloys, silicon carbide, silicon-based chemicals, and the silicones.

Arsenic Pentaselenide.[1492] Arsenic pentaselenide, $As_2Se_5$, is a black, brittle solid with a metallic luster. It is insoluble in water and decomposes when heated in air. It may be prepared by melting a mixture of arsenic and selenium in correct proportions at about 400 C in a sealed tube filled with nitrogen gas and distilling the resulting mass under reduced pressures to obtain pure arsenic pentaselenide. It may also be prepared by the reaction of an arsenic salt with hydrogen selenide in solution. Arsenic pentaselenide is of limited commercial importance.

Tantalum.[1433,1570] Tantalum, Ta, is a gray, heavy, and very hard metal. It occurs principally in the mineral columbite-tantalite. The metal has a high melting point exceeded only by tungsten and rhenium. At temperatures below 150 C, it is almost completely inert to chemical attack. Commercial production of tantalum is carried out in two major steps: (1) extraction and purification of a pure tantalum compound from the ore; and (2) reduction of such a compound to pure metal. The extraction and purification step may be accomplished by either (1) an alkali fusion of the ore followed by acid treatment to remove most of the impurities and fractional crystallization to obtain a pure potassium fluotantalate, $K_2TaF_7$; or (2) extraction of the ore by hydrofluoric acid followed by liquid-liquid extraction using methyl isobutyl ketone (MIBK) and precipitation with ammonia to yield hydrated tantalum oxide. The reduction step may be carried out by:

(1) electrolysis of molten potassium fluotantalate;

(2) reduction of potassium fluotantalate by sodium pellets;

(3) reduction of tantalum oxide by carbon or tantalum carbide.

Its uses are:

(1) in making electrolytic capacitors, lightning arrestors, surge suppressors;

(2) in fabricating chemical process equipments, nuclear reactors; aircraft and missile parts, surgical instruments;

(3) as an implant metal for the human body in surgery;

(4) in special-purpose vacuum tubes.

## Sources and Types of Wastes

The wastes of materials discussed in this report may come from the following sources:

(1) mining and metal refining facilities;

(2) industrial plants which either produce these materials or use them in their manufacturing processes;

(3) users of products containing these materials.

Practically, all the wastes are in the form of unused or contaminated materials.

## Physical and Chemical Properties

Physical and chemical properties of the materials in this report are given in the attached worksheets.

## 2. TOXICITY[0766]

The antimony compounds, including the sulfides and sulfate, generally cause irritation and eczematous eruption of the skin, inflammation of the mucous membranes of the nose and throat, metallic taste and stomatitis, gastrointestinal upset with vomiting and diarrhea, and various nervous complaints such as irritability, sleeplessness, fatigue, dizziness, and muscular and neuralgic pains.

The toxic effect of calcium fluoride comes from its fluorine component. In general, inorganic fluorides are toxic and irritant to the eyes and respiratory tract. Acute effects resulting from exposure to fluorine compounds are due to hydrogen fluoride. Among the chronic fluorine poisoning commonly encountered are loss of weight, anorexia, anemia, wasting and cachexia, and dental defects. The very low solubility of the calcium fluoride, however, requires exposure to large quantities of the material to produce these symptoms.

Magnesium, aluminum and tantalum are all nontoxic metals. However, inhalation of magnesium powder may cause irritation of the respiratory tract. Particles of magnesium which perforate the skin or gain entry through cuts and scratches may produce a severe local lesion characterized by the evolution of gas and acute inflammatory reaction, frequently with necrosis. This condition has been known as "chemical gas gangrene". The lesion is very slow to heal. Similarly, aluminum powder can be irritating to the eyes. There are also reports in the European literature of chronic pulmonary disease due to the inhalation of aluminum dust. Tantalum appears to have no ill effect upon the human body. Tantalum metal embedded in the abdominal wall and in the bones of dogs cause no physiological disturbances. So far, the use of tantalum in human surgery has received favorable comments.

Silica occurs abundantly in nature. Prolonged inhalation of silica dusts may result in a diffuse fibrosis known as silicosis. The duration of exposure required for the development of silicosis varies widely from 2 to 30 years. This fibrosis is, to a certain extent, progressive, and may continue to develop for several years after exposure is terminated. The first and most common symptom of silicosis is the shortness of breath on exertion. The most common physical sign is a limitation of chest expansion. There may be a dry cough with increased susceptibility to tuberculosis. Further progress of the disease results in more severe shortness of breath and cough, marked fatigue, extreme dyspnea and cyanosis, loss of appetite, pleuritic pain and total incapacity to work. If tuberculosis does not supervene, the conditions may eventually cause death from either cardiac failure or destruction of lung tissue with resultant anoxemia.

Arsenic pentaselenide is a toxic chemical. Selenium resembles arsenic both chemically and physiologically. Poisoning due to selenium compounds generally results in gastrointestinal disturbances, respiratory irritation, cough, edema of the lungs, vomiting, diarrhea, abdominal pain or cramps, loss of reflexes, convulsions and ultimately death. Selenium salts also often cause contact dermatitis. Poisoning due to arsenic compounds may be acute or chronic. Acute poisoning, usually from ingestion, results in marked irritation of the stomach and intestines with nausea, vomiting and diarrhea. In severe cases the vomitus and stools are bloody and the patient goes into collapse and shock with weak, rapid pulse, cold sweats, coma and death. Chronic arsenic poisoning, through ingestion or inhalation, causes disturbances of the digestive system such as loss of appetite, nausea, constipation or diarrhea, damage to the liver resulting in jaundice, disturbances to the blood, kidneys and nervous systems. Arsenic can also cause a variety of skin abnormalities including itching, pigmentation and even cancerous changes.

The Threshold Limit Value (TLV) recommended by the American Conference of Governmental Industrial Hygienists and lethal doses reported for the materials in this report are given as follows:

| Chemicals | TLV[0225] | Lethal Dose[1312] |
|---|---|---|
| Antimony Pentasulfide | 0.5 mg as $Sb/M^3$ | ip $LD_{50}$: 1000 mg/kg, rat |
| Antimony Sulfate | 0.5 mg as $Sb/M^3$ | ip LD: 1000 mg/kg, rat[1492] |
| Antimony Trisulfide | 0.5 mg as $Sb/M^3$ | ip $LD_{Ca}$: 1000 mg/kg, rat |
| Calcium Fluoride | 2.5 mg as $F/M^3$ | or LD: 5000 mg/kg, guinea pig[1492] |
| Mixture Powdered Magnesium and Aluminum | -- | or $LD_{Ca}$: 230 mg Mg/kg, dog |
| Silica | -- | or $LD_{50}$: 3160 mg/kg, rat |
| Arsenic Pentaselenide | 0.5 mg as $As/M^3$ | -- |
| Tantalum | -- | -- |

## 3. OTHER HAZARDS

The antimony sulfides would undergo spontaneous chemical reactions with powerful oxidizers to cause moderate fire and explosion hazards. In addition, both antimony pentasulfide and sulfate would decompose when heated, resulting in a mild fire hazard.

Metallic powder of magnesium and aluminum can be ignited easily.

Arsenic pentaselenide is a hazardous chemical when heated to decomposition or on contact with acid or acid fumes, because it would emit the highly toxic fumes of arsenic and selenium.

## 4. DEFINITION OF ADEQUATE WASTE MANAGEMENT

### Handling, Storage, and Transportation

In handling the materials discussed in this report, care must be exercised to avoid inhaling silica dust particles and metallic powder of aluminum and magnesium. In storage, the antimony sulfides and sulfate and arsenic pentaselenide must be stored in cool areas and away from powerful oxidizers and acids. All toxic materials should be kept away from food and feed products. Metallic powder of aluminum and magnesium can be ignited easily. Therefore, they should be kept away from flame, and spark-proof tools should be used where they are being shoveled or otherwise moved by hand. In addition, magnesium should be kept dry, because it will react with water or steam to generate the combustible hydrogen gas. Similarly, antimony sulfate deliquesces in moist air and hence should be kept tightly closed in dry areas.

### Disposal/Reuse

For the majority of the materials in this report, recovery of the wastes for reuse appears to be desirable, because they are, in general, not produced in large quantities and are relatively costly. For the safe disposal of these materials, the recommended allowable exposure limit in air and in water are tabulated as follows:

| Contaminant in Air | Allowable Exposure Limit | Basis for Recommendation |
|---|---|---|
| Antimony Pentasulfide | 0.005 mg as Sb/$M^3$/24 hr | TLV |
| Antimony Sulfate | 0.005 mg as Sb/$M^3$/24 hr | TLV |
| Antimony Trisulfide | 0.005 mg as Sb/$M^3$/24 hr | TLV |
| Calcium Fluoride | 0.025 mg as F/$M^3$/24 hr | TLV |
| Powdered Magnesium, Aluminum Mixture | -- | -- |
| Silica | -- | -- |
| Arsenic Pentaselenide | 0.005 mg as As/$M^3$/24 hr | TLV |
| Tantalum | -- | -- |

| Contaminants in Water | Allowable Exposure Limit Man | Allowable Exposure Limit Fish | Basis for Recommendation* |
|---|---|---|---|
| Antimony Pentasulfide | 0.05 mg as Sb/1 | 0.05 mg as Sb/1 | CTS |
| Antimony Sulfate | 0.05 mg as Sb/1 | 0.05 mg as Sb/1 | CTS |
| Antimony Trisulfide | 0.05 mg as Sb/1 | 0.05 mg as Sb/1 | CTS |
| Calcium Fluoride | 0.6-1.7 mg as F/1 | 0.6-1.7 mg as F/1 | DWS |
| Mixture Powder Magnesium and Aluminum | 125 mg as Mg/1 | 125 mg as Mg/1 | DWS |
| Silica | -- | -- | -- |
| Arsenic Pentaselenide | 0.5 mg as As/1 | 0.05 mg as As/1 | DWS |
| Tantalum | -- | -- | -- |

---

*CTS - Computed values based on chronic toxicity drinking water studies.

*DWS - U.S. Public Health Service, Drinking Water Standards.

## 5. EVALUATION OF DISPOSAL/RECOVERY PROCESSES

### Option No. 1 - Landfill

The materials in this report are insoluble in water and therefore may be conveniently disposed of by landfill. However, arsenic pentaselenide is highly toxic, and the disposal of arsenic pentaselenide wastes by landfill is not recommended. For the other materials in this report, particularly expensive metal such as tantalum, waste recovery should be considered and preferred over disposal by landfill.

### Option No. 2 - Long Term Storage for Arsenic Pentaselenide

Large, weatherproof, and siftproof storage bins or silos are currently being used for the storage of arsenic compounds, especially arsenic trioxide. This approach is relatively costly. However, since arsenic pentaselenide is highly toxic and its wastes only appear in small quantities, long term storage of the arsenic pentaselenide waste may be the only practical and adequate means of disposal.

### Option No. 3 - Sulfide Precipitation

The antimony sulfides and sulfate can be recovered from the wastes by first dissolving the wastes in concentrated hydrochloric acid, fitering the resulting solution if necessary, and finally saturating the solution with hydrogen sulfide to precipitate out the antimony sulfide which is then removed by filtration. The sulfides may be marketed or roasted and reduced to recover metallic antimony, or the sulfides placed in containers and stored at a National Disposal Site.

## Option No. 4 - Mechanical Salvaging

Expensive metal such as tantalum is worth salvaging, even in small pieces, and should be sorted out mechanically. Since tantalum is chemically inert at ordinary temperatures, scraps of tantalum can be cleaned by removing the contaminants with strong acid.

## Option No. 5 - Recovery of Metallic Antimony

Antimony sulfides may be roasted to yield the oxide which can be reduced to metallic antimony by carbon or by salt and scrap iron. The sulfur dioxide produced by the roasting must be scrubbed from the exhaust gas stream. A great number of scrubbing processes are available for this purpose. Among the commonly used processes are scrubbing the exhaust gas containing sulfur dioxide with an acidified, aqueous suspension of finely ground limestone or an aqueous solution of soda ash.

## 6. APPLICABILITY TO NATIONAL DISPOSAL SITES

Waste treatment for the materials discussed in this Profile Report is commonly found in an industrial environment and therefore, treatment facilities need not be present at a National Disposal Site. The Arsenic Selenide and Antimony Sulfide wastes must be controlled and therefore it is recommended that these materials be permenantly stored at a National Disposal Site if they cannot be economically recovered.

# 7. REFERENCES

0225. American Conference of Governmental Industrial Hygienists. Threshold limit values for 1971. Occupational Hazards, p. 35-40, Aug. 1971.

0766. Sax, N. I. Dangerous properties of industrial materials. 3d ed. New York, Reinhold Publishing Corporation, 1968. 1,251 p.

1312. Christensen, H. E., ed. Toxic substances annual list 1971. Washington, U.S. Government Printing Office, 1971. 512 p.

1433. Kirk-Othmer encyclopedia of chemical technology. 2d ed. New York, Interscience Publishers, 1966.

1492. The Merck index of chemicals and drugs. 7th ed. Rahway, New Jersey, Merck Company, Inc., 1960. 1,634 p.

1570. Weast, R. C., ed. Handbook of chemistry and physics. 48th ed. Cleveland, Ohio, Chemical Rubber Company, 1969. 2,100 p.

2275. Mellor, J. W. A comprehensive treatise on inorganic and theoretical chemistry. v. 7. New York, John Wiley & Sons, Inc., 1963.

37

## HAZARDOUS WASTES PROPERTIES WORKSHEET

H. M. Name Antimony Pentasulfide

IUC Name ____________

Common Names ____________

Structural Formula

$Sb_2S_5$

Molecular Wt.(1) 403.82 Melting Pt.(1) decomposes @ 75 C Boiling Pt. --

Density (Condensed) 4.12(1) @____ ____ Density (gas) ________ @ ______ ______

Vapor Pressure (recommended 55 C and 20 C)

________ @ ________ ________ @ ________ ________ @ ________

Flash Point ________ Autoignition Temp. ____

Flammability Limits in Air (wt %) Lower ________ Upper ________

Explosive Limits in Air (wt. %) Lower ________ Upper ________

Solubility (1)

Cold Water insoluble Hot Water insoluble Ethanol insoluble

Others: soluble in HCl, alkali, $NH_4HS$

Acid, Base Properties ____________

Highly Reactive with ____________

Compatible with ____________

Shipped in ____________

ICC Classification ____________ Coast Guard Classification ____________

Comments ____________

References (1) 1570

39

## HAZARDOUS WASTES PROPERTIES WORKSHEET

H. M. Name Antimony Sulfate

IUC Name

Common Names

Structural Formula

Molecular Wt.(1) 531.68 Melting Pt.(1) decomposes Boiling Pt. --

Density (Condensed) 3.625(1) @ Density (gas) @

Vapor Pressure (recommended 55 C and 20 C)

@ @ @

Flash Point Autoignition Temp.

Flammability Limits in Air (wt %) Lower Upper

Explosive Limits in Air (wt. %) Lower Upper

Solubility (1)

Cold Water insoluble Hot Water decomposes Ethanol --

Others: soluble in acid

Acid, Base Properties

Highly Reactive with

Compatible with

Shipped in

ICC Classification Coast Guard Classification

Comments

References (1) 1570

40

## HAZARDOUS WASTES PROPERTIES
## WORKSHEET

H. M. Name Antimony Trisulfide

IUC Name

Common Names

Structural Formula

$Sb_2S_3$

Molecular Wt.(1) 339.69 Melting Pt.(1) 550 C Boiling Pt.(1) Ca 1150 C

Density (Condensed) 4.12(1) @ Density (gas) @

Vapor Pressure (recommended 55 C and 20 C)

@ @ @

Flash Point Autoignition Temp.

Flammability Limits in Air (wt %) Lower Upper

Explosive Limits in Air (wt. %) Lower Upper

Solubility (1)

Cold Water 0.000175 g/100 ml @ 18 C Hot Water -- Ethanol soluble

Others: soluble in HCl, $K_2S$, $NH_4HS$

Acid, Base Properties

Highly Reactive with

Compatible with

Shipped in

ICC Classification Coast Guard Classification

Comments

References (1) 1570

92

## HAZARDOUS WASTES PROPERTIES WORKSHEET

H. M. Name Calcium Fluoride

IUC Name

Common Names

Structural Formula

$CaF_2$

Molecular Wt.(1) 78.08 Melting Pt.(1) 1360 C Boiling Pt.(1) ca 2500 C

Density (Condensed) 3.18(1) @ Density (gas) @

Vapor Pressure (recommended 55 C and 20 C)

@ @ @

Flash Point Autoignition Temp.

Flammability Limits in Air (wt %) Lower Upper

Explosive Limits in Air (wt. %) Lower Upper

Solubility (1)

Cold Water 0.0016 g/100 ml @ 18 C Hot Water 0.0017 g/100 ml @ 26 C Ethanol

Others: soluble in ammonium salts

Acid, Base Properties

Highly Reactive with

Compatible with

Shipped in

ICC Classification Coast Guard Classification

Comments

References (1) 1570

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## HAZARDOUS WASTES PROPERTIES WORKSHEET

H. M. Name Silica

IUC Name

Common Names

Structural Formula

$SiO_2$

Molecular Wt.(1) 60.08 Melting Pt.(1) 1610 C Boiling Pt.(1) 2230 C

Density (Condensed) 2.64-2.66(1) @ Density (gas) @

Vapor Pressure (recommended 55 C and 20 C)

@ @ @

Flash Point Autoignition Temp.

Flammability Limits in Air (wt %) Lower Upper

Explosive Limits in Air (wt. %) Lower Upper

Solubility (1)

Cold Water insoluble Hot Water insoluble Ethanol insoluble

Others: soluble in HF

Acid, Base Properties

Highly Reactive with

Compatible with

Shipped in

ICC Classification Coast Guard Classification

Comments Silica exists in a variety of forms. The density and melting point given here are those of quartz.

References (1) 1570

467

# HAZARDOUS WASTES PROPERTIES
WORKSHEET

H. M. Name Arsenic Pentaselenide

IUC Name ____

Common Names ____

Structural Formula

$As_2Se_5$

Molecular Wt.(1) 544.62 Melting Pt.(1) decomposes Boiling Pt. ____

Density (Condensed) ____ @ ____ ____ Density (gas) ____ @ ____ ____

Vapor Pressure (recommended 55 C and 20 C)

____ @ ____ ____ @ ____ ____ @ ____

Flash Point ____ Autoignition Temp. ____

Flammability Limits in Air (wt %) Lower ____ Upper ____

Explosive Limits in Air (wt. %) Lower ____ Upper ____

Solubility (1)

Cold Water insoluble Hot Water ____ Ethanol insoluble

Others: soluble in alkali hydroxides and sulfides

Acid, Base Properties ____

Highly Reactive with ____

Compatible with ____

Shipped in ____

ICC Classification ____ Coast Guard Classification ____

Comments ____

References (1) 1492

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## HAZARDOUS WASTES PROPERTIES
## WORKSHEET

H. M. Name Tantalum

IUC Name

Common Names

Structural Formula

Ta

Molecular Wt.(1) 127.6    Melting Pt.(1) 449.5 ± 0.3 C    Boiling Pt.(1) 989.8 ± 3.8 C

Density (Condensed) 6.0 @    Density (gas) @

Vapor Pressure (recommended 55 C and 20 C)

@    @    @

Flash Point    Autoignition Temp.

Flammability Limits in Air (wt %)    Lower    Upper

Explosive Limits in Air (wt. %)    Lower    Upper

Solubility (1)

Cold Water insoluble    Hot Water insoluble    Ethanol

Others: soluble in $H_2SO_4$, $HNO_3$, aqua regia, KCN, KOH

Acid, Base Properties

Highly Reactive with

Compatible with

Shipped in

ICC Classification    Coast Guard Classification

Comments

References (1) 1570

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# PROFILE REPORT

## Antimony Potassium Tartrate (38)

## 1. GENERAL

### Introduction

Potassium antimony tartrate, $K(SbO)C_4H_4O_6 \cdot 1/4H_2O$, occurs as transparent, odorless crystals or as a white powder. It is manufactured by heating antimony trioxide with a solution of potassium bitartrate followed by crystallization. It is used as a textile and leather mordant, medicine (emetic), insecticide and in perfumery.[1442]

### Physical/Chemical Properties

The physical/chemical properties for potassium antimony tartrate are summarized on the attached worksheet.

## 2. TOXICITY

Although potassium antimony tartrate is used medicinally as an emetic, the therapeutic dose is close to the toxic dose. It can cause cough, metallic-taste, salivation, nausea, and diarrhea. Large doses can cause severe liver damage.[0766] The dose for an emetic is 30 mg by mouth. The lethal dose for the mouse is reported as $LD_{50}$ 600 mg/Kg (as Sb). For man the $LD_{ca}$ is reported to be 2 mg/Kg as potassium antimony tartrate.[1536]

## 3. OTHER HAZARDS

None.

## 4. DEFINITION OF ADEQUATE WASTE MANAGEMENT

### Handling, Storage and Transportation

There are no special handling or storage requirements. There are no DOT or Coast Guard shipping requirements but a Manufacturing Chemists Association warning label is applied to all containers which states "may be fatal if swallowed." It is shipped in 25-, 50-, and 250-lb drums and in 425- and 625-lb barrels.[1416]

### Disposal/Reuse

Contaminated potassium antimony tartrate is not normally reprocessed for reuse, but instead is treated for disposal. Safe disposal is here defined as processing which meets the safe exposure limit in water that is critical for fish, 9 mg per liter.[1536]

## 5. EVALUATION OF WASTE DISPOSAL PROCESSES

Potassium antimony tartrate is dissolved in water, 6M-HCl is added to the solution to make it acid and the solution is then saturated with hydrogen sulfide. The precipitated $Sb_2S_3$ is filtered, washed, dried and packaged for shipment to a company which markets antimony sulfide.[0095] If there is no market, the antimony sulfide is placed in storage in containers protected from rain or snow.

## 6. APPLICABILITY TO NATIONAL DISPOSAL SITES

Potassium antimony tartrate wastes are easily treated by the process described above in Section 5 at the site of origin. The toxicity of antimony compounds requires that their disposal be controlled to protect man and his environment. If a market for the antimony sulfide recovered from the waste treatment process cannot be identified and permanent storage is required, it is recommended that the materials be stored at a National Disposal Site.

# 7. REFERENCES

0095. Manufacturing Chemists Association. Laboratory waste disposal manual. 2d ed. Washington, 1969. 176 p.

0225. American Conference of Government Industrial Hygienists. Threshold limit values for 1971. Occupational Hazards, 35:35-40, Aug. 1971.

0776. Sax, N. I. Dangerous properties of industrial materials. 2d., New York, Reinhold Publishing Corporation, 1957. 1,457 p.

1416. Ross, A. and E. Ross. Condensed chemical dictionary. 6th ed. New York, Reinhold Publishing Corporation, 1961. 1,256 p.

## HAZARDOUS WASTES PROPERTIES
## WORKSHEET

H. M. Name Antimony Potassium Tartrate

IUC Name

Common Names Tartar emetic

Structural Formula

$K(SbO)C_4 H_4O_6 \cdot 1/4H_2O$

Molecular Wt. 333.94(1)    Melting Pt. $-1/2H_2O$ at 100 C(1)    Boiling Pt.

Density (Condensed) @    Density (gas) @

Vapor Pressure (recommended 55 C and 20 C)

@    @    @

Flash Point    Autoignition Temp.

Flammability Limits in Air (wt %)    Lower    Upper

Explosive Limits in Air (wt. %)    Lower    Upper

Solubility

Cold Water soluble(2)    Hot Water soluble(2)    Ethanol insoluble(2)

Others:

Acid, Base Properties Aqueous solution slightly acid(2)

Highly Reactive with

Compatible with

Shipped in drums and barrels

ICC Classification none(2)    Coast Guard Classification none(2)

Comments

References (1) 0766
(2) 1416

# PROFILE REPORT

## Butyl Phenol (78), Carbolic Acids (97), Cresol (124), Cresylic Acid (125), Ethyl Phenol (196), Nonyl Phenol (314), Phenol (327), Xylenol (452), Diethylstilbestrol (492).

## 1. GENERAL

### Introduction

The materials treated in this report belong to the class of organic chemicals called phenols. They are distinguished by the presence of at least one hydroxyl (-OH) group, attached directly to a benzene ring. This group of materials has been previously identified as probable candidates for disposal by methods commonly available to municipalities. They have been grouped for discussion because of the similarities in their chemical behavior and in the applicable methods for their disposal.

### Manufacture and Use

Several of these phenolic materials comprise mixtures of isomeric compounds obtained from natural sources. For example, cresol, synonymous with cresylic acid, is a mixture of the three isomeric, monomethyl phenols obtained by the distillation of coal tar.[1492] It has an unpleasant phenolic odor and may range in color from almost colorless to dark brown, depending on age, exposure to light and original purity. Cresol is used as an intermediate in the manufacture of synthetic resins and as a local antiseptic and disinfectant.[1492]

The six xylenol isomers are also derived from coal tar by distillation and are sometimes constituents of "cresylic acid." They are used in the preparation of disinfectants and synthetic resins.

Butyl, ethyl and nonyl phenol are manufactured by alkylation of phenol with the appropriate olefin in the presence of an acid catalyst. These sterically hindered phenols are used as antioxidants and as intermediates in the manufacture of antioxidants and synthetic resins.[1433]

Phenol, at one time obtained principally from natural sources, is now prepared by a number of synthetic processes. The major portion of the phenol manufactured in this country is produced by the cumene peroxidation process and by alkaline hydrolysis of chlorobenzene. The preparation of phenolic resins consumes 50 percent of the phenol used. The rest of the production is employed in the synthesis of monomers for other resins (e.g., caprolactam, bisphenol-A and adipic acid) and of other commodities.[1506]

There are a number of possible synthetic routes to diethylstilbestrol using a variety of starting materials. It is used in estrogenic hormone therapy in humans, as an aid to increase weight gain in cattle, sheep and pigs, and as a caponization agent for poultry.[1492]

### Physical and Chemical Properties

The physical and chemical properties of the compounds discussed in this report are included in the attached worksheets.

## 2. TOXICOLOGY[0766,1492,2351]

All of the phenolic compounds discussed in this report, with the exception of diethylstilbestrol, have toxicological effects which are similar to those of phenol itself. The principal effect is on the central nervous system, manifested by headache, dizziness and muscular weakness followed, in acute cases, by loss of consciousness, collapse and death. Solid and liquid phenols have a corrosive effect on body tissues and fatal doses are readily absorbed through the skin. The severity of the toxicity and corrosiveness of the substituted phenols varies with the nature of the substitution, but it is generally less extreme than that of the unsubstituted material.

Diethylstilbestrol is less corrosive to body tissues than the other materials treated in this report. When employed in hormone therapy it has shown such side effects as gastrointestinal upset, dizziness, menstrual disturbances and headache. Its use has been associated with cell damage and is therefore contraindicated during pregnancy and lactation. There has been a great deal of concern recently with birth defects possibly caused by ingestion of meat containing trace amounts of diethylstilbestrol used to fatten cattle. This possibility is now under intensive investigation and the future use of diethylstilbestrol as a feed additive is in question.

## 3. OTHER HAZARDS[0766]

All of these phenols are considered slight fire hazards when exposed to heat or flame. However, they must be considered as moderately dangerous because of the toxic fumes emitted when they are heated to decomposition.

## 4. DEFINITION OF ADEQUATE WASTE MANAGEMENT

### Handling, Storage and Transportation

The most important considerations with regard to the handling, storage and transportation of these materials are provisions for adequate ventilation in work areas and stringent fire prevention procedures. Personnel handling these phenols must be supplied with protective clothing to prevent skin and eye contact.[2351]

### Disposal/Reuse

Material which is contaminated in such a manner as to preclude its processing for reuse must be disposed of by a process which is safe as defined by the provisional exposure limits given below:

| Substance | Limit for Air (Man) ppm | Limit for Air (Man) mg/M³ | Limit for Water (Man) ppm |
|---|---|---|---|
| Phenol (carbolic acid) | 0.05 | 0.19 | 0.001 DWS* |
| Cresol (cresylic acid) | 0.05 | 0.22 | 0.001 DWS* |
| Ethyl Phenol | | | |
| Butyl Phenol | | | |
| Nonyl Phenol | | | |
| Diethylstilbestrol | | | |

* Drinking Water Standards

## 5. EVALUATION OF WASTE MANAGEMENT STANDARDS

### Option No.1 - Biological Treatment of Aqueous Wastes

Phenolic compounds, with few exceptions, have been found to show very little resistance to acclimated microorganisms.[1543] The use of biological treatment processes, particularly activated sludge, is a recommended method for the disposal of aqueous wastes containing these materials and of concentrated phenolic wastes after they have been extensively diluted with water.

### Option No.2 - Incineration

Controlled incineration of phenolic wastes is a currently used and acceptable method for the disposal of organic and aqueous wastes containing these materials.[0285]

## 6. APPLICABILITY TO NATIONAL DISPOSAL SITES

Wastes containing the materials discussed in this report may be properly disposed of by incineration or biological treatment, provided that no other contaminants are present which preclude the use of those methods. Since the equipment necessary for the implementation of these processes are commonly available at municipal and industrial facilities, these materials are not judged to be candidates for the National Disposal Sites.

# 7. REFERENCES

0285 Lund, H.F., ed. Industrial pollution control handbook. New York, McGraw-Hill Book Company, 1971. 843 p.

0766 Sax, I.R., Dangerous properties of industrial materials. 3d ed. New York, Reinhold Publishing Corporation, 1968. 1,251 p.

1433 Kirk-Othmer encyclopedia of chemical technology. 3d ed. 22 V. New York, Interscience Publishers, 1966.

1492 The Merck index of chemicals and drugs. 7th ed. Rahway, New Jersey, Merck Company, Inc., 1960. 1,634 p.

1506 Oil, paint and drug reported profiles. New York, Schnell Publishing Company, Inc., 1970.

1543 Ludzack, F.J., M.B. Ettinger. Chemical structures resistant to aerobic chemical stabilization. Journal Water Pollution Control Federation, 32(11):1173-1200, Nov. 1960.

1570 Weast, R.C., ed. Handbook of chemistry and physics. 48th ed. Cleveland, Ohio, Chemical Rubber Company, 1969. 2,100 p.

1571 Schnell Publishing Company. 1971-72 OPD chemical buyers guide. 1971. 1584 p.

2351 Baskin, A.D., ed. Handling guide for potentially hazardous commodities. Chicago, Railway Systems and Management Association, 1972.

## HAZARDOUS WASTES PROPERTIES WORKSHEET

78

H. M. Name Butyl Phenol

IUC Name 4-t-butylphenol

Common Names p-t-butylphenol, butylphen

Structural Formula

$C_4H_9C_6H_4OH$

Molecular Wt. 150.21(1) Melting Pt. 98 C(1) Boiling Pt. 237 C(1)

Density (Condensed) 0.9081 @ 114/4 C Density (gas) 5.1(2) @

Vapor Pressure (recommended 55 C and 20 C)

1 mm @ 70 C(2) @ @

Flash Point Autoignition Temp.

Flammability Limits in Air (wt %) Lower Upper

Explosive Limits in Air (wt. %) Lower Upper

Solubility

Cold Water insoluble(1) Hot Water Ethanol soluble

Others: ether

Acid, Base Properties weak acid

Highly Reactive with

Compatible with

Shipped in

ICC Classification Coast Guard Classification

Comments volatile with steam,(2). Sources(3): CPS Chemical Co., Fallek Products Co., Productol Chemical Co.

References (1) 1492
(2) 0766
(3) 1571

## HAZARDOUS WASTES PROPERTIES WORKSHEET

196

H. M. Name Ethyl Phenol

IUC Name 1-ethyl-2-hydroxybenzene

Common Names 2-ethylphenol, o-ethylphenol, phlorol

Structural Formula

$C_2H_5C_6H_4OH$

Molecular Wt. 122.17 Melting Pt. <-18 C Boiling Pt. 207 C(1)

Density (Condensed) 1.0371 (1) @ 0 C Density (gas) @

Vapor Pressure (recommended 55 C and 20 C)

10 mm @ 84.1 C @ @

Flash Point Autoignition Temp.

Flammability Limits in Air (wt %) Lower Upper

Explosive Limits in Air (wt. %) Lower Upper

Solubility

Cold Water slightly soluble(1) Hot Water Ethanol soluble

Others: ether, acetone, benzene

Acid, Base Properties weak acid

Highly Reactive with

Compatible with

Shipped in

ICC Classification Coast Guard Classification

Comments

References (1) 1570

## HAZARDOUS WASTES PROPERTIES WORKSHEET

H. M. Name Nonyl Phenol

IUC Name

Common Names p-nonyl phenol

Structural Formula

$C_9H_{19}C_6H_4OH$

Molecular Wt. 220.34 Melting Pt. Boiling Pt. 290-301 C(1)

Density (Condensed) 0.949 @ 20/4 C Density (gas) 7.59(1) @

Vapor Pressure (recommended 55 C and 20 C)

@ @ @

Flash Point 300 F (T.O.C.)(1) Autoignition Temp.

Flammability Limits in Air (wt %) Lower Upper

Explosive Limits in Air (wt. %) Lower Upper

Solubility

Cold Water very slight(2) Hot Water Ethanol soluble

Others: benzene, chlorinated solvents, heptane

Acid, Base Properties

Highly Reactive with

Compatible with

Shipped in

ICC Classification Coast Guard Classification

Comments Sources(3): Fallek Chemical Corp., ICI American Inc., Jefferson Chemical Co., Productol Chemical Co., Rohm and Hass Co., Stepan Chemical Co.,

References (1) 0766
(2) 1492
(3) 1571

## HAZARDOUS WASTES PROPERTIES WORKSHEET

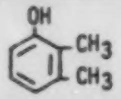
452 a

H. M. Name Xylenol

IUC Name 2,3-dimethylphenol

Common Names vic-o-xylenol

Structural Formula



Molecular Wt. 122.16 Melting Pt. 75 C(1) Boiling Pt. 218 C(1)

Density (Condensed) @ Density (gas) @

Vapor Pressure (recommended 55 C and 20 C)

@ @ @

Flash Point Autoignition Temp.

Flammability Limits in Air (wt %) Lower Upper

Explosive Limits in Air (wt. %) Lower Upper

Solubility

Cold Water slightly soluble(1) Hot Water Ethanol soluble

Others: chloroform, ether, benzene

Acid, Base Properties

Highly Reactive with

Compatible with

Shipped in

ICC Classification Coast Guard Classification

Comments

References (1) 1492

## HAZARDOUS WASTES PROPERTIES
## WORKSHEET

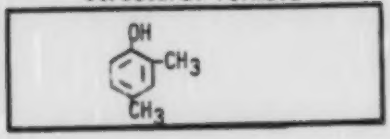
452 b

H. M. Name Xylenol

IUC Name 2,4-dimethylphenol

Common Names as-m-xylenol

Structural Formula



Molecular Wt. 122.16
Melting Pt. 25.4-26 C(1)
Boiling Pt. 211.5 C(1)

Density (Condensed) @
Density (gas) @

Vapor Pressure (recommended 55 C and 20 C)

@
@
@

Flash Point
Autoignition Temp.

Flammability Limits in Air (wt %) Lower Upper
Explosive Limits in Air (wt. %) Lower Upper

Solubility

Cold Water slightly soluble(2)
Hot Water
Ethanol soluble

Others: chloroform, ether, benzene

Acid, Base Properties

Highly Reactive with

Compatible with

Shipped in

ICC Classification
Coast Guard Classification

Comments Sources(2): Aceto Chemical Co., Profuctol Chemical Co.

References (1) 1492
(2) 1571

## HAZARDOUS WASTES PROPERTIES WORKSHEET

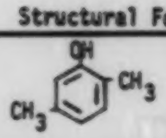
452 c

H. M. Name Xylenol

IUC Name 2,5-dimethylphenol

Common Names p-xylenol

Structural Formula



Molecular Wt. 122.16 Melting Pt. 74.5 C(1) Boiling Pt. 211.5 C(1)

Density (Condensed) @ Density (gas) @

Vapor Pressure (recommended 55 C and 20 C)

@ @ @

Flash Point Autoignition Temp.

Flammability Limits in Air (wt %) Lower Upper

Explosive Limits in Air (wt. %) Lower Upper

Solubility

Cold Water slightly soluble(1) Hot Water Ethanol soluble

Others: chloroform, ether, benzene

Acid, Base Properties

Highly Reactive with

Compatible with

Shipped in

ICC Classification Coast Guard Classification

Comments Sources(2): M.W. Hardy & Co., Productol Chemical Co.

References (1) 1492

(2) 1571

HAZARDOUS WASTES PROPERTIES
WORKSHEET

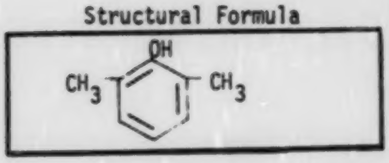
452 d

H. M. Name Xylenol

IUC Name 2,6-dimethylphenol

Common Names vic-m-xylenol

Structural Formula



Molecular Wt. 122.16 Melting Pt. 49 C(1) Boiling Pt. 203 C(1)

Density (Condensed) @ Density (gas) @

Vapor Pressure (recommended 55 C and 20 C)

@ @ @

Flash Point Autoignition Temp.

Flammability Limits in Air (wt %) Lower Upper

Explosive Limits in Air (wt. %) Lower Upper

Solubility

Cold Water slightly soluble(1) Hot Water Ethanol soluble

Others: chloroform, ether, benzene

Acid, Base Properties

Highly Reactive with

Compatible with

Shipped in

ICC Classification Coast Guard Classification

Comments Source(2): M.W. Hardy & Co.

References (1) 1492
(2) 1571

## HAZARDOUS WASTES PROPERTIES
## WORKSHEET

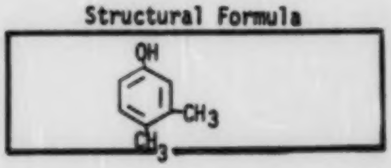
452 e

H. M. Name Xylenol

IUC Name 3,4-dimethylphenol

Common Names as-o-xylenol

Structural Formula



Molecular Wt. 122.16 Melting Pt. 62.5 C(1) Boiling Pt. 225 C(1)

Density (Condensed) @ Density (gas) @

Vapor Pressure (recommended 55 C and 20 C)

@ @ @

Flash Point Autoignition Temp.

Flammability Limits in Air (wt %) Lower Upper

Explosive Limits in Air (wt. %) Lower Upper

Solubility

Cold Water slightly soluble(1) Hot Water Ethanol soluble

Others: chloroform, ether, benzene

Acid, Base Properties

Highly Reactive with

Compatible with

Shipped in

ICC Classification Coast Guard Classification

Comments Sources(2): M.W. Hardy & Co., Koppers Co., Productol Chemical Co.

References (1) 1492
(2) 1571

452 f

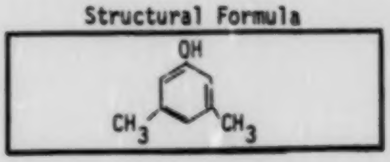
## HAZARDOUS WASTES PROPERTIES WORKSHEET

H. M. Name Xylenol

IUC Name 3,5-dimethylphenol

Common Names sym-m-xylenol

Structural Formula



Molecular Wt. 122.16 Melting Pt. 64 C(1) Boiling Pt. 219.5 C(1)

Density (Condensed) @ Density (gas) @

Vapor Pressure (recommended 55 C and 20 C)

@ @ @

Flash Point Autoignition Temp.

Flammability Limits in Air (wt %) Lower Upper

Explosive Limits in Air (wt. %) Lower Upper

Solubility

Cold Water slightly soluble(1) Hot Water Ethanol soluble

Others: chloroform, ether, benzene

Acid, Base Properties

Highly Reactive with

Compatible with

Shipped in

ICC Classification Coast Guard Classification

Comments Sources(2): M.W. Hardy & Co., Loppers Co.

References (1) 1492
(2) 1571

## HAZARDOUS WASTES PROPERTIES WORKSHEET

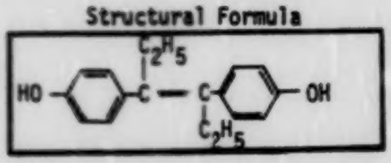
492

H. M. Name Diethylstilbestrol

IUC Name 4,4'-dihydroxy-α,β-diethylstilbene

Common Names stilbestrol

Structural Formula



Molecular Wt. 268.34 Melting Pt. 169-172 C(1) Boiling Pt.

Density (Condensed) @ Density (gas) @

Vapor Pressure (recommended 55 C and 20 C)

@ @ @

Flash Point Autoignition Temp.

Flammability Limits in Air (wt %) Lower Upper

Explosive Limits in Air (wt. %) Lower Upper

Solubility

Cold Water almost insoluble(1) Hot Water Ethanol soluble

Others: ether, chloroform, fatty oils, dilute hydroxides(1)

Acid, Base Properties neutral(1)

Highly Reactive with

Compatible with

Shipped in

ICC Classification Coast Guard Classification

Comments Sources(2): Abbott Laboratories, American Roland Corp., Chemetron Corp., Desmo Chemical Corp.

References (1) 1492
(2) 1571

124.125

## HAZARDOUS WASTES PROPERTIES WORKSHEET

H. M. Name Cresol, Cresylic Acid

IUC Name

Common Names cresylol, tricresol

Structural Formula

$CH_3C_6H_4OH$

Molecular Wt. 108.1 Melting Pt. 10.9-35.5 C(1) Boiling Pt. 191-203 C(1)

Density (Condensed) 1.030-1.038 @ 25/25 C(1) Density (gas) 3.72(1) @

Vapor Pressure (recommended 55 C and 20 C)

1 mm @ 38-53 C(1) @ @

Flash Point 110 F(1) Autoignition Temp.

Flammability Limits in Air (wt %) Lower Upper

Explosive Limits in Air (wt. %) Lower Upper 1.35 @ 300 F

Solubility

Cold Water 50 parts(2) Hot Water Ethanol miscible

Others: benzene, ether, glycerol, petroleum, ether, alkali.(2)

Acid, Base Properties acid

Highly Reactive with oxidizing agents(1)

Compatible with

Shipped in

ICC Classification Coast Guard Classification

Comments Sources(3): Concord Chemical Co., Crowley Tar Products, Co., Fallek Chemical Corp., Koppers Co., Pitt-Concol Chemical Co., Productol Chemical Co., Tar Residuals, USS Chemicals.

References (1) 0766
(2) 1492
(3) 1571

## HAZARDOUS WASTES PROPERTIES
## WORKSHEET

97,327

H. M. Name Carbolic Acid, Phenol

IUC Name phenol

Common Names phenic acid, phenylic acid

Structural Formula

$C_6H_5OH$

Molecular Wt. 94.11 Melting Pt. 40.6 C(1) Boiling Pt. 181.9 C(1)

Density (Condensed) 1.072(1) @ ____ Density (gas) 3.24(1) @ ____

Vapor Pressure (recommended 55 C and 20 C)

1 mm @ 40.1 C(1) ____ @ ____ ____ @ ____

Flash Point 175 F (C.C.)(1) Autoignition Temp. 1319 F(1)

Flammability Limits in Air (wt %) Lower ____ Upper ____

Explosive Limits in Air (wt. %) Lower ____ Upper ____

Solubility

Cold Water 1 g in 15 ml(2) Hot Water ____ Ethanol soluble

Others: chloroform, ether, glycerol, carbon disulfide(2)

Acid, Base Properties acid(2)

Highly Reactive with oxidizing materials(1)

Compatible with ____

Shipped in ____

ICC Classification Poison B(1) Coast Guard Classification Poison B(1)

Comments Sources(3): Allied Chemical Corp., Browning Chemical Corp., Dow Chemical Co., and many others.

References (1) 0766
(2) 1492
(3) 1571

# PROFILE REPORT

## Cobalt Nitrate (116), Ferrous Sulfate (198), Stannous Chloride (409), Cobalt Chloride (489)

## 1. GENERAL

### Introduction

The inorganic chemicals in this Profile Report are grouped together because they can be handled by similar disposal processes. Concentrated aqueous solutions of the salts constitute a hazard or nuisance.

### Manufacture and Uses

Cobalt Nitrate. Cobalt nitrate, or cobaltous nitrate, $Co(NO_3)_2$, is a red crystalline material which is deliquescent in moist air. Cobaltous nitrate is prepared by the action of nitric acid on cobalt hydroxide followed by purification through recrystallization. It is used in:[1492]

(1) sympathetic inks;

(2) cobalt pigments;

(3) preparation of cobalt catalysts;

(4) additives to soils and animal feeds;

(5) additives to vitamin preparations;

(6) hair dyes;

(7) decorations on porcelain.

Ferrous Sulfate. Ferrous sulfate, $FeSO_4 \cdot 7H_2O$, crystals or granules are green, and are often brownish-yellow in color from oxidation and efflorescence. The sources of commercial ferrous sulfate are:

(1) by-product production (from the pickling of steel and from many other chemical operations);
(2) direct reaction between dilute sulfuric acid and iron;
(3) oxidation of pyrites in air, followed by leaching and treatment with scrap iron;
(4) by-product production from ilmenite.

The uses for ferrous sulfate include:[0955, 1492, 1662]

(1) water purification;
(2) source for other iron salts and oxides;
(3) fertilizer;
(4) feed additive;
(5) writing inks;
(6) pigments;
(7) medicine;
(8) deodorizer;
(9) metallurgy;
(10) aluminum etching;
(11) wood preservative compositions.

Stannous Chloride. Stannous chloride, $SnCl_2$, is a white crystalline mass that absorbs oxygen from the air to form the insoluble oxychloride. It is prepared by dissolving tin in hydrochloric acid. $SnCl_2$ is used:[1492]

(1) as a reducing agent in the manufacture of chemicals and dyes;
(2) in tin galvanizing;
(3) as a reagent in analytical chemistry;
(4) as a stain remover;
(5) in antisludging agents for lubricating oils;
(6) as a chemical preservative.

Cobalt Chloride. Cobalt chloride or cobaltous chloride, $CoCl_2 \cdot 6H_2O$, is prepared by recrystallization of the crude material obtained by reacting hydrochloric acid with cobalt oxide. It is used:[1492]

(1) as an absorbent for ammonia;
(2) in gas masks;
(3) in electroplating;
(4) in sympathetic inks;
(5) in hygrometers;
(6) in catalysts;
(7) in barometers;
(8) as a flux for magnesium refining
(9) as a trace element in feeds and in vitamin $B_{12}$ preparation.

## Physical/Chemical Properties

The physical/chemical properties for the compounds covered by this Profile Report are summarized on the attached worksheets.

## 2. TOXICITY

Stannous chloride is considered relatively nontoxic. Ferrous sulfate, although used as a diet supplement, has caused death when excessive quantities were ingested. Lowest lethal dose was 0.5 gm.[2376] The cobalt salts have $LD_{50}$'s which range from 100 to 400 mg/Kg for mouse and rabbit.

With the exception of $FeSO_4$, which has a Threshold Limit Value (TLV) of 1 mg/$M^3$ as Fe,[0225] the American Conference of Governmental Industrial Hygienists has not established TLV's for any of the compounds listed in this report. The recommended provisional limits for the compounds in air and water are listed below:

| Contaminant | Provisional Limits | |
|---|---|---|
| | Air mg/$M^3$ | Water mg/l |
| Cobalt Nitrate | 0.001 as Co | 0.05 as Co |
| Ferrous Sulfate | 0.01 as Fe | 0.03 as Fe |
| Cobalt Chloride | 0.001 as Co | 0.05 as Co |
| Stannous Chloride | 0.02 as Sn | 0.05 as Sn |

## 3. OTHER HAZARDS

Cobaltous nitrate is an oxidizing material which, in contact with organic or other readily oxidizable substances, may cause a violent reaction or combustion. Ferrous sulfate in aqueous solution will corrode iron and most steels.[1492] The iron, cobalt, and tin salts listed all hydrolyze to produce acid solutions.

## 4. DEFINITION OF ADEQUATE WASTE MANAGEMENT

### Handling, Storage, and Transportation

As discussed in Section 3, cobaltous nitrate is an oxidizing material and must be handled and stored as such. It is classified by DOT and the Coast Guard as an oxidizing material that requires a Yellow Label.[0776] Ferrous sulfate etches iron and aluminum; 316 stainless steel is relatively unaffected by $FeSO_4$, and is used in contact with aqueous solutions. Other than protection from moisture there are no additional handling, storage or transportation requirements for the compounds included in this Profile Report.

### Disposal/Reuse

The inorganic chemicals discussed in this report can be reprocessed for reuse if both quality and quantity of the waste discharged are consistent with economic recovery. If disposal is required, the disposal process is regarded as safe if the effluents from the disposal process meet the recommended provisional limits given in Section 2.

## 5. EVALUATION OF WASTE DISPOSAL PROCESSES

The Manufacturing Chemists Association has recommended disposal of packaged lots of the materials in this report as follows. The salts are dissolved in a large excess of water, and treated with a slight excess of soda ash which precipitates the cobalt, ferric and tin ions.[0095] When the sulfate ion is present, slaked lime is also added to reduce the sulfate ion concentration. After standing 24 hours, the supernatant liquid is decanted into another container and neutralized with hydrochloric acid, and the liquid is diluted further before discharge into a sewer or stream. The sludge is added to a landfill.

## 6. APPLICABILITY TO NATIONAL DISPOSAL SITES

The materials discussed in this report have been classified on a preliminary basis as probable candidates for municipal disposal. Based on the discussion of disposal in Section 5, it may be concluded that after preliminary treatment with soda ash (and lime when sulfate ions are present) the treated wastes can be discharged into municipal sewers or streams. Because waste treatment can be handled adequately locally, these compounds do not merit consideration for treatment at National Disposal Sites.

# 7. REFERENCES

0095. Manufacturing Chemists Association. Laboratory waste disposal manual. 2d ed. Washington, 1969. 176 p.

0225. American Conference of Governmental Industrial Hygienists. Threshold limit values for 1971. Occupational Hazards, 35:35-40, Aug. 1971.

0776. Sax, N. I. Dangerous properties of industrial materials. 2d ed. New York, Reinhold Publishing Corporation, 1957. 1,467 p.

0955. Sittig, Marshall. Inorganic chemical and metallurgical process encyclopedia. Park Ridge, New Jersey, Noyes Development Corporation, 1968. 883 p.

1492. Ross, A. and E. Ross. Condensed chemical dictionary. 6th ed. New York, Reinhold Publishing Corporation, 1961. 1,256 p.

1570 Chemical Rubber Company. Handbook of chemistry and physics. 47th ed. Cleveland, Chemical Rubber Company, 1966. 1,500 p.

1662. Shreve, R. N. Chemical process industries. 2d ed. New York, McGraw-Hill Book Company, 1956. 1,004 p.

2376. Gleason, M. N., R. C. Gosselin, H. C. Hodge, and R. P. Smith. Clinical toxicity of commercial products. 3d ed. Baltimore, Maryland, The Williams and Wilkins Company, 1969.

## HAZARDOUS WASTES PROPERTIES
## WORKSHEET

H. M. Name Cobalt Nitrate

IUC Name Cobaltous Nitrate

Common Names

Structural Formula

$Co(NO_3)_2 \cdot 6H_2O$

Molecular Wt. 291.05(1) Melting Pt. <100 C(1) Boiling Pt. $-3H_2O$, 55 C(1)

Density (Condensed) 1.87g/cc @ 20 C(1) Density (gas) @

Vapor Pressure (recommended 55 C and 20 C)

@ @ @

Flash Point Autoignition Temp.

Flammability Limits in Air (wt %) Lower Upper

Explosive Limits in Air (wt. %) Lower Upper

Solubility

Cold Water 138.8g/100 ml at 0 C(1) Hot Water very soluble(1) Ethanol 100 ml at 12 C(1)

Others:

Acid, Base Properties

Highly Reactive with

Compatible with

Shipped in Glass bottles, wooden barrels(2)

ICC Classification oxidizing material(2) Coast Guard Classification oxidizing material(2)

Comments

References (1) 1570
(2) 1492

## HAZARDOUS WASTES PROPERTIES
## WORKSHEET

H. M. Name Ferrous Sulfate

IUC Name

Common Names Copperas, Iron Sulfate

Structural Formula

$FeSO_4 \cdot 7H_2O$

Molecular Wt. 278.01

Melting Pt. 64 C, $-6H_2O$

Boiling Pt. 300 C, $-7H_2O$

Density (Condensed) 1.898g/cc @ 20 C(1)

Density (gas) @

Vapor Pressure (recommended 55 C and 20 C)

@ @ @

Flash Point

Autoignition Temp.

Flammability Limits in Air (wt %) Lower Upper

Explosive Limits in Air (wt. %) Lower Upper

Solubility

Cold Water 15.65g/100 ml(1)

Hot Water 48.6g/100 ml at 50 C(1)

Ethanol Insoluble

Others:

Acid, Base Properties

Highly Reactive with

Compatible with

Shipped in Bottles, bags, barrels, bulk

ICC Classification None(2)

Coast Guard Classification None(2)

Comments

References (1) 1570
(2) 1492

## HAZARDOUS WASTES PROPERTIES
## WORKSHEET

H. M. Name Stannous Chloride

IUC Name Stannous Chloride

Common Names Tin Chloride

Structural Formula

$SnCl_2$

Molecular Wt. 189.61(1) Melting Pt. 264.0 C(1) Boiling Pt. 623 C(1)

Density (Condensed) 3.393g/cc liquid @ 245 C(1) Density (gas) @

Vapor Pressure (recommended 55 C and 20 C)

@ @ @

Flash Point Autoignition Temp.

Flammability Limits in Air (wt %) Lower Upper

Explosive Limits in Air (wt. %) Lower Upper

Solubility

Cold Water 83.9g/100 ml at 10 C(1) Hot Water 269.8g/100 ml at 15 C(1) Ethanol soluble(1)

Others:

Acid, Base Properties

Highly Reactive with

Compatible with

Shipped in bottles, drums(2)

ICC Classification none(2) Coast Guard Classification none(2)

Comments

References (1) 1570
(2) 1492

## HAZARDOUS WASTES PROPERTIES
## WORKSHEET

H. M. Name Cobalt chloride

IUC Name Cobaltous chloride

Common Names

Structural Formula

$CoCl_2$

Molecular Wt. 129.85(1) Melting Pt. subl.(1) Boiling Pt. 1049 C(1)

Density (Condensed) 3.356g/cc @ 30 C(1) Density (gas) @

Vapor Pressure (recommended 55 C and 20 C)

@ @ @

Flash Point Autoignition Temp.

Flammability Limits in Air (wt %) Lower Upper

Explosive Limits in Air (wt. %) Lower Upper

Solubility

Cold Water 45g/100 ml at 7 C(1) Hot Water 105g/100 ml at 96 C(1) Ethanol 54.4g/100 ml(1)

Others: acetone 8.6g/100 ml(1)

Acid, Base Properties

Highly Reactive with

Compatible with

Shipped in Bottles, tins, drums(2)

ICC Classification None(2) Coast Guard Classification None(2)

Comments

References (1) 1570
(2) 1492

# PROFILE REPORT

## Contaminated Electrolyte (118)

### 1. GENERAL

All elements which could normally make up a contaminated electrolyte residue are covered in one of the following Profile Reports:

| | |
|---|---|
| Cadmium Cyanides | (84) |
| Chrome | (113) |
| Copper Cyanides | (120) |
| Cyanides | (129) |
| Nickel Cyanide | (295) |
| Silver Cyanide | (370) |
| Zinc Cyanide | (457) |
| Hexavalent Chromium - | (21), (22), (343), (345), (379), (386) |

With the one exception of chrome, all of the above are recommended as candidates for National Disposal Sites.

## PROFILE REPORT

Diethylether (152), Dioxane (153), Ethers (174), Ethylene Glycol Monoethyl Ether (187), Ethylene Glycol Monoethyl Ether Acetate (188), Isopropyl Ether (232), Polypropylene Glycol Methyl Ether (339), Propylene Oxide (362), Tetrahydrofuran (426)

## 1. GENERAL

### Introduction[1433]

Ethers are compounds of the type R-O-R' where R and R' may be the same or different alkyl or aryl radicals. Ethers resemble the corresponding hydrocarbons in chemical reactivity, provided there are no additional, more reactive functional groups present. On prolonged exposure to air, ethers autooxidize to peroxides, which can be dangerously explosive.

### Manufacture[1433]

Catalytic Dehydration of Alcohols - This preparative method is used principally for the production of simple ethers (e.g., ethyl ether). The reaction usually involves several of the reaction steps outlined below, the particular combination of steps employed is governed by the identity of the desired product.

$$ROH + HOSO_2OH \xrightarrow{\text{Cold}} ROSO_2OH + HOH$$

$$ROSO_2OH + ROH \xrightarrow{\Delta} ROR + H_2SO_4$$

$$ROSO_2OH + ROH \xrightarrow{\Delta} ROSO_2OR + HOH$$

$$ROSO_2OR + ROH \xrightarrow{\Delta} ROR + ROSO_2OH$$

Williamson Ether Synthesis - The Williamson ether synthesis may be used to prepare either simple (R=R') or mixed ethers ($R \neq R'$).

$$RBr + NaOR' \longrightarrow ROR' + NaBr$$

## Uses and Application[1433,2401]

The principal applications of ethers are as solvents for organic reactions and extractions, as plasticizers, as vehicles for other products and as anesthetics. Ethers are insoluble in water, but are solvents for many organic compounds, and therefore, have found wide application in paint and varnish removers, as high-boiling solvents for gums, resins and waxes, and in lubricating oil. The vapors of certain ethers are toxic to insects and are useful as agricultural insecticides and industrial fumigants.

Diethylether - Ethyl ether is a good solvent or extractant for fats, waxes, oils, perfumes, resins, dyes, gums, and alkaloids. When mixed with ethyl alcohol, ethyl ether becomes an excellent solvent for cellulose nitrate in the manufacture of guncotton, collodion solutions and pyroxylene plastics. It is used as a general anesthetic in surgery.

Dioxane - Dioxane is employed as a solvent for cellulose acetate, ethyl cellulose, benzyl cellulose, resins, oils, waxes, oil and spirit-soluble dyes and many other organic as well as for some inorganic compounds.

Ethyleneglycol Monomethyl Ether - This material is used as a solvent for low viscosity cellulose acetate, natural resins, some synthetic resins and some alcohol-soluble dyes. It is also used in dyeing leather, sealing moisture proof cellophane, quick-drying varnishes and enamel nail polish, and in wood stains.

Ethyleneglycol Monoethyl Ether - This ether-alcohol is used to prepare bis($\beta$-halo) derivatives of ethyleneglycol monoethyl ether and as a solvent for nitrocellulose, lacquers and dopes in varnish remover, cleaning solutions, dye baths, and in leather finishing.

Isopropyl Ether - This material may be converted to the alcohol or used as motor fuel additive. It is also used as a solvent in certain extraction processes and as a solvent in the manufacture of pharmaceuticals, smokeless powder, paint and varnish removers, and rubber cements.

Polypropylene Glycol Methyl Ether - This material is used as a component in lubricants.

Propylene Oxide - This epoxide is used in the manufacture of alkanolamines, polypropylene glycols, propylene glycol and in paint removers.

Tetrahydrofuran - This cyclic ether is used as a plasticizer, in paint removers, and as a solvent for high polymers. It is also employed in the synthesis of butyrolactone, succinic acid, and 1,4-butanediol diacetate.

## Physical and Chemical Properties

The physical and chemical properties of these ethers are included in the attached worksheets.

## 2. TOXICOLOGY

The principal hazard in industrial use and handling of the ethers is from inhalation of their vapors. As a class, they do not penetrate the skin in harmful amounts nor are they irritating to the skin.[2401] The simpler ethers such as ethyl ether, isopropyl ether, etc., are powerful narcotics which in large doses can cause death.

## 3. OTHER HAZARDS

The more volatile ethers, such as ethyl and methyl ether, are particularly dangerous fire hazards because of their low ignition and flash points. Peroxides, which form in ethers upon standing pose the additional threat of detonation when an ether is heated after prolonged storage.[0766]

## 4. DEFINITION OF ADEQUATE WASTE MANAGEMENT

### Handling, Storage and Transportation

Stringent safety precautions must be taken to guard against health and fire hazards whenever ethers are handled. The area in which highly flammable ethers are stored or used should be posted with "No Smoking" or other appropriate warning signs. If leaks or spills occur, only properly protected personnel should remain in the area. Leaking containers should be removed to the outdoors or to an isolated, well-ventilated area, and the contents transferred to other suitable containers. All spills should be flushed away promptly with water.

Ordinarily, ethyl ether will start to oxidize soon after distillation. Storage time required for this induction period, the rate at which oxidation will proceed and the quantity of peroxides that will be produced, may vary widely and will depend upon condtions that are not entirely understood. Ether peroxides are not as volatile as the corresponding ether and tend to concentrate during evaporation or distillation. Ether peroxides, when concentrated, may detonate with extreme violence.

Ether which is to be used in any process that will involve evaporation or distillation, must pass a standard test. Ethers failing the test must be treated to remove the peroxides.[2402]

Drums and other portable containers of ethyl ether should be stored out of the direct rays of the sun and away from sources of heat. These precautions are applicable to all of the lower, more volatile ethers.

A list of hazardous materials with packing and shipping instructions is found in Code of Federal Regulations, title 49, parts 100 to 199 (accession No. 278) and shipping instructions for ethyl ether are found in the Manufacturing Chemist's Association bulletin SD-29.[2402]

## Disposal/Reuse

Contaminated or degraded materials found to be unusable in a recycling process must be disposed of in a safe manner, defined in terms of the recommended maximum concentrations released to the environment. These recommended maximum concentrations are as follows:

| Contaminant in Air | Provisional Limits | Basis for Recommendation |
|---|---|---|
| Diethylether | 4 ppm (12 mg/M$^3$)/24 hrs | 0.01 TLV |
| Dioxane | 1.0 ppm (3.6 mg/M$^3$)/24 hrs | 0.01 TLV |
| Ethylene glycol monoethyl ether | | |
| Ethylene glycol monoethyl ether acetate | | |
| Isopropyl ether | | |
| Polypropylene glycol methyl ether | | |
| Propylene oxide | 1.0 ppm (2.4 mg/M$^3$)/24 hrs | 0.01 TLV |
| Tetrahydrofuran | 2.0 ppm (5.9 mg/M$^3$)/24 hrs | 0.01 TLV |

| Contaminant in Water and Soil | |
|---|---|
| Diethylether | 60 mg/l |
| Dioxane | 18 mg/l |
| Ethylene glycol monoethyl ether | |
| Ethylene glycol monoethyl ether acetate | |
| Isopropyl ether | |
| Polypropylene glycol methyl ether | |
| Propylene oxide | 12 mg/l |
| Tetrahydrofuran | 29.5 mg/l |

## 5. EVALUATION OF CURRENT AND NEAR FUTURE DISPOSAL PROCESSES

### Option 1 - Recycling of Concentrated Waste

It would be advisable in all cases to first contact the manufacturer to determine if the material can be recycled. The applicability of this option depends on the type and extent of contamination or degradation the material has suffered.

## Option 2 - Disposal of Concentrated Waste Containing no Peroxides[2402]

Prime factors to consider in the disposal of ethers are: possible presence of peroxides in liquid or on container elements; low flash point; vapors are much heavier than air; liquid is highly flammable; vapor forms explosive mixture with air; and it can accumulate static electrical charges that may ignite its vapors.

Waste materials containing lower ethers should not be emptied into drains or sewers, as sewer explosions are likely to result. The vapors will travel long distances before dissipation, and a steam or process line may be hot enough to effect ignition.

Where there is certainty that peroxides are not present, disposal may be accomplished by discharging liquid (not vapor) at a controlled rate near a pilot flame. An inert gas line connected to the vapor phase and a valve controlled line from the bottom of the container will permit a gravity feed of the liquid to a pilot flame at a safe distance. The inert gas avoids contact of the liquid with air and will inert the vapor space in the container. The rate of burning can be valve controlled. Lines and containers should be grounded.

## Option 3 - Disposal of Concentrated Waste Suspected of Containing Peroxides[2402]

Where peroxides are known to exist, or it is suspected that they might exist, it is suggested that no attempt be made to open the containers. (Peroxides tend to form in the threads of bungs and caps, and are easily ignited by the frictional heat generated when these closures are turned). Handling of the containers should be minimized. The containers should be destroyed from an upwind position of 100 feet or more away, using rifle fire so aimed that most of the ether will be forced to spill on the ground and evaporate. This should be done at a remote location, away from habitation, where no harm to the public or surroundings can occur. It should be remembered that there is always the possibility that fire may ensue or the container might explode. Alternatively, a blasting cap or small explosive charge may be used to perforate the container from a safe distance.

### Option 4 - Incineration of Dilute Organic Wastes

Dilute organic waste can be safely incinerated provided the burning temperature is sufficiently high to reduce the waste to $CO_2$ and water.

### Option 5 - Incineration of Dilute Aqueous Waste

Since ethers generally resist biological degradation,[0314] dilute aqueous waste containing ethers above preliminary limits for water and soil can be disposed of by incineration. It is recommended that dilute aqueous waste be thermally oxidized by spraying the aqueous solution into an incinerator which is at a temperature of at least 1500 F.

## 6. APPLICABILITY TO NATIONAL DISPOSAL SITES

Most of the wastes generated by the industries that produce and use these materials can best be handled and treated at the site of the generation by methods discussed in Section 5. Since adequate methods are available for disposal of these materials and they can be implemented by the manufacturers and users, they are not judged to be candidates for National Disposal Sites.

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#152

## HAZARDOUS WASTES PROPERTIES
## WORKSHEET

H. M. Name Diethyl ether

IUC Name

Common Names Diethyl Ether
Sulfuric ether; anesthesic ether

Structural Formula

$C_2H_5OC_2H_5$

Molecular Wt. 74.12(1) Melting Pt. -116.2 C(1) Boiling Pt. 34.6 C(1)

Density (Condensed) 0.7135 @ 20/4 C Density (gas) @

Vapor Pressure (recommended 55 C and 20 C)

442 mm @ 20 C(1) 760 mm @ 34.6 C(1) @

Flash Point -40 F(1) Autoignition Temp. 356 F(1)

Flammability Limits in Air (wt %) Lower Upper

Explosive Limits in Air (wt. %) Lower Upper

Solubility (3)

Cold Water Soluble Hot Water Ethanol Soluble in all proportions

Others: Benzene, chloroform, oils, ligroin

Acid, Base Properties

Highly Reactive with

Compatible with

Shipped in

ICC Classification Coast Guard Classification

Comments Sources(3): Allied Chemical Corp; Amsco Division; Ashland Chemical Co; Corco Chemical Corp; Mallinckrodt Chemical Works; McKesson Chemical Co; Mutchler Chemical Co; Publicker Industries Inc; Thompson-Hayward Chemical Co.

References (1) 0766
(2) 1570
(3) 1571

#187

## HAZARDOUS WASTES PROPERTIES WORKSHEET

H. M. Name Ethylene glycol Monoethyl Ether

IUC Name 2-methoxyethanol(1)

Common Names

Structural Formula

$CH_3OCH_2CH_2OH$

Molecular Wt. 76.11(1)    Melting Pt. -85.1(1)    Boiling Pt. 125(1)

Density (Condensed) 0.9647(1) @ 204 4 C    Density (gas) @

Vapor Pressure (recommended 55 C and 20 C)

@    @    @

Flash Point    Autoignition Temp.

Flammability Limits in Air (wt %)    Lower    Upper

Explosive Limits in Air (wt. %)    Lower    Upper

Solubility (1)

Cold Water Infinite    Hot Water    Ethanol Very soluble

Others: Ether, benzene

Acid, Base Properties Neutral

Highly Reactive with

Compatible with

Shipped in

ICC Classification    Coast Guard Classification

Comments Sources(2): Eastman Chemical Products. Celanese Chemical Co; Union Carbide Corporation.

References (1) 1570
(2) 1571

#188

## HAZARDOUS WASTES PROPERTIES WORKSHEET

H. M. Name Ethyleneglycol monoethyl ether acetate

IUC Name

Common Names Ethylene Glycol Monoethyl-Ether Acetate ("Cellusolve" Acetate)

Structural Formula

$CH_3COOCH_2CH_2OC_2H_5$

Molecular Wt. 132.17(1) Melting Pt. -61.7 C(1) Boiling Pt. 156.4 C(1)

Density (Condensed) 0.9748 @ 20/20 C(1) Density (gas) 4.72(1) air = 1.00 @

Vapor Pressure (recommended 55 C and 20 C)

1.2 mm @ 20 C(1) @ @

Flash Point 120 F(1) Autoignition Temp. 715 F(1)

Flammability Limits in Air (wt %) Lower Upper

Explosive Limits in Air (wt. %) Lower 1.71 percent L.E.L. Upper

Solubility(3)

Cold Water Hot Water Ethanol Soluble

Others: Ether, acetone

Acid, Base Properties

Highly Reactive with

Compatible with

Shipped in

ICC Classification Coast Guard Classification

Comments Sources(2): A.I.D. Chemical Co; Amsco Division; Ashland Chemical Co; CPS Chemical Co; Celanese Chemical Co; Eastman Chemical Products; Stoney-Mueller Inc; Thompson-Hayward Chemical Co; Union Carbide Co.

References (1) 0766

(2) 1571

(3) 1570

#232

## HAZARDOUS WASTES PROPERTIES WORKSHEET

H. M. Name Isopropyl Ether

IUC Name

Common Names Isopropyl ether
2-Isopropoxypropane

Structural Formula

$(CH_3)_2CHOCH(CH_3)_2$

Molecular Wt. 102.17(1) Melting Pt. -60 C(1) Boiling Pt. 68.5 C(1)

Density (Condensed) 0.719 @ 25 C(1) Density (gas) 3.52(1) air = 1.00 @

Vapor Pressure (recommended 55 C and 20 C)

150 mm @ 25 C(1) 400 mm @ 48.2 C(2) @

Flash Point -18 F(1) Autoignition Temp. 830 F(1)

Flammability Limits in Air (wt %) Lower Upper

Explosive Limits in Air (wt. %) Lower 1.4 percent Upper 21.0 percent

Solubility(2)

Cold Water Slightly soluble Hot Water Ethanol Soluble in all proportions

Others: Ether

Acid, Base Properties

Highly Reactive with

Compatible with

Shipped in

ICC Classification Coast Guard Classification

Comments Sources(3): A.I.D. Chemical Co; Allied Chemical Corp; Amsco Division; Publicker Industries; F. H. Ross & Co; Ruger Chemical Co; Shell Chemical Co; Stoney-Mueller Inc; Suburban Chemical Co; Thompson-Hayward Chemical Co; Union Carbide Corp.

References (1) 0766
(2) 1570
(3) 1571

#362

## HAZARDOUS WASTES PROPERTIES WORKSHEET

H. M. Name Propylene oxide

IUC Name

Structural Formula

$OCH_2CHCH_3$

Common Names Propylene Oxide
1,2-Epoxypropane, Propene oxide

Molecular Wt. 58.08(1) Melting Pt. -104.4 C(1) Boiling Pt. 33.9 C(1)

Density (Condensed) 0.8304 @ 20/20 C(1) Density (gas) 2.0(1) air = 1.00 @

Vapor Pressure (recommended 55 C and 20 C)

400 mm @ 17.8 C(1) 760 mm @ 33.9 C(1) @

Flash Point -35 F(1) Autoignition Temp.

Flammability Limits in Air (wt %) Lower Upper

Explosive Limits in Air (vol %) Lower 2.1% Upper 21.5%

Solubility(2)

Cold Water Soluble in 100 parts Hot Water Ethanol Soluble

Others: Ether

Acid, Base Properties

Highly Reactive with

Compatible with

Shipped in

ICC Classification Coast Guard Classification

Comments Sources(3): BASF Wyandotte Cor; Dow-Chemical Co; Jefferson Chemical Co; Olin Chemicals; Oxirane Corp; Union Carbide Corp.

References (1) 0766
(2) 1492
(3) 1571

#426

## HAZARDOUS WASTES PROPERTIES WORKSHEET

H. M. Name Tetrahydrofuran

IUC Name

Common Names Tetrahydrofuran
Cyclotetramethylene

Structural Formula

$OCH_2CH_2CH_2CH_2$

Molecular Wt. 72.10(1) Melting Pt. -108.5 C(1) Boiling Pt. 65.4 C(1)

Density (Condensed) 0.888 @ 20/4 C(1) Density (gas) 2.5(1) air = 1.00 @

Vapor Pressure (recommended 55 C and 20 C)

114 mm @ 15 C(1) @ @

Flash Point 1 F(1) Autoignition Temp.

Flammability Limits in Air (wt %) Lower Upper

Explosive Limits in Air (wt. %) Lower Upper

Solubility(3)

Cold Water Soluble Hot Water Ethanol Soluble

Others: Ketones, ethers, hydrocarbons

Acid, Base Properties

Highly Reactive with

Compatible with

Shipped in

ICC Classification Coast Guard Classification

Comments Sources(3): Ashland Chemical Co; Conray Products Co; E. I. duPont de Nemours & Co; International Chemical Corp; McKesson Chemical Co; Pyramid Chemical Sales Co; Quaker Oats Co; Western Eaton Solvents & Chemicals Co.

References (1) 0766
(2) 1492
(3) 1571

#153

## HAZARDOUS WASTES PROPERTIES WORKSHEET

H. M. Name Dioxane

IUC Name

Common Names Diethylene dioxide
Dioxane

Structural Formula

$OCH_2CH_2OCH_2CH_2$

Molecular Wt. 88.10(1) Melting Pt. 10 C(1) Boiling Pt. 101.1 C(1)

Density (Condensed) 1.0353 @ 20/4 C Density (gas) @

Vapor Pressure (recommended 55 C and 20 C)

40 mm @ 25.2 C(1) 100 mm @ 45.1 C(2) @

Flash Point 54 F(1) Autoignition Temp. 356 F(1)

Flammability Limits in Air (wt %) Lower Upper

Explosive Limits in Air (wt. %) Lower 1.97 percent Upper 22.2 percent(1)

Solubility(2)

Cold Water Soluble in all proportions Ethanol Soluble in all proportions

Others: Ether, acetone, organic solvents, acetic acid

Acid, Base Properties

Highly Reactive with

Compatible with

Shipped in

ICC Classification Coast Guard Classification

Comments Mfg.(3): Amsco Division; Ashland Chemical Co; J. T. Baker Chemical Co; Corco Chemical Co; Grant Chemicals, Inc; MCAB Manufacturing Chemists; Southland Solvents and Chemical Co; Stoney-Mueller, Inc; Union Carbide Corp.

References (1) 0766
(2) 1570
(3) 1571

## PROFILE REPORT

## Copper (275), Lead & Zinc (276) Mill Tailings

## 1. GENERAL

### Processing

The mill tailings environmental problems stemming from the production of copper, lead and zinc have been grouped in this Profile Report since the major ores (all sulphides) of these materials are concentrated in a similar manner. Though vast quantities of finely ground wastes are produced, they are in themselves innocuous and it is only the leachate of contained minerals or the small quantities of floatation reagents which are contained which could constitute hazards.

Typically, the processes involved in the production of a concentrate of the mineral of interest and the attendant waste product (tailings) for copper, lead, zinc follow this pattern:

(1) Crushing
(2) Gravity Separation (Lead and Zinc)
(3) Grinding
(4) Flotation Separation

Crushing. Crushing[2486] is predominantly 3-stage, comprising almost universally a jaw or gyratory crusher as the primary stage, a cone crusher as the secondary machine, and rolls or short-head cone crushers as the third stage. Oversize material from each stage of crushing is normally separated by grizzlies or screens and recirculated.

Gravity Separation. "The coarsely disseminated ores of lead, lead-silver, and lead-zinc, with gangue of average specific gravity (2.6 to 2.8) yield important quantities of high-grade lead concentrate by gravity concentration on jigs and/or tables."[2486]

Grinding. The crushed ore is then ground to an average size sufficient to liberate the ore mineral from the gangue (35 to 48 mesh or as fine as necessary to free the minerals). As in the crushing stage, oversize material is recirculated. In order to obtain the required recoveries a large amount of the material must of necessity be ground much finer than the average.

Flotation. Taggart's "Handbook of Mineral Dressing"[2486] describes flotation as a method of concentrating minerals in a relatively finely divided state. It is essentially a method of gravity concentration in water in which the effective specific gravity of the ore minerals is substantially decreased by causing air bubbles to attach to particles of the particular mineral of interest whereupon they float on the separating medium while the unaffected minerals (tailings) sink.

After grinding, the steps in froth flotation are: (1) dilution to a pulp consistency of 15 to 35 percent solids; (2) addition to the pulp of small quantities of conditioning agents, (burned lime or sulphuric acid for pH adjustment-1 to 4 lbs/ton, sodium cyanide, etc. .2 to 2 lbs/ton of ore), which prepare the mineral surfaces; (3) addition of a collector reagent which has the function of coating the mineral to be floated with a water repellant film (xanthates are commonly used for Cu, Pb and Zn-0.04 to 0.2 lbs/ton of ore); (4) addition of a frothing agent which imparts persistence to bubbles when they reach the surface (pine oils, eucalyptus oil, alcohols, etc. --0.4 to 0.1 lbs/ton of ore); (5) aeration by agitation or by air injection of a combination of the two; (6) separation of the mineral bearing froth from the liquid pulp containing the residual pulp.

## 2. ORES & CONCENTRATES

### Copper

As described in Taggart's "Handbook of Mineral Dressing"[2486] the primary sulfide economic minerals of copper are bornite [$Cu_5$ Fe $S_4$], Chalcocite [$Cu_2S$], Chalcopyrite [Cu Fe $S_2$], or native copper [Cu]. Copper is found in practically every type of ore deposit and associated, in one place or another, with practically every metallic and rock-forming mineral. The largest and best-known deposits are the sulphide-vein deposits of Montana, the native-copper deposits of the Lake Superior region, and the "oxidized" and "porphyry" deposits of the southwestern United States. At Butte, Montana, the ore-bearing veins occur in granite, the chief copper minerals are chalcocite, enargite [$Cu_3$ (As, Sb) $S_4$], bornite, and chalcopyrite, and the principal associated vein minerals are quartz and pyrite. In the Lake Superior region the native copper, associated with native silver, occurs as part of the cementing matter in a conglomerate, as a cavity filling in lava beds, and in veins cutting both igneous and sedimentary rocks. The usual gangue minerals are calcite and zeolites. The "oxidized" deposits of the southwest carry amounts of the oxidized copper minerals, malachite, azurite, and cuprite, and directly below or closely associated with these, bonanzas of massive secondary chalcocite. Both classes of minerals are derived from the primary copper sulphides, largely chalcopyrite and cupriferous pyrite, which are found unaltered in greater depths. The deposits occur in limestone or at limestone-porphyry contacts. The "porphyry coppers" are mineralized zones in granitic porphyries and schists. The principal copper mineral is chalcocite, which occurs as grains and veinlets in the country rock. Pyrite, chalcopyrite, and magnetite are the principal metallic associates; quartz and the rock-forming silicates form the nomentallic gangue.

## Concentrate

Copper ores may contain native copper (one mine operating in the United States) or either of the three sulphides, chalcocite, bornite of chalcopyrite, as the principal value-bearing constituent; in which case a given weight of copper-bearing mineral will carry respectively 100, 80, 56, or 35 parts of copper per 100 parts of pure concentrate, with a corresponding limitation on the highest possible grade of concentrate that can be made.

Most of the United States production (over 90%)[1975] is presently derived from five western states. Most of the remainder comes from Michigan and Tennessee. Fifteen of the leading mines are located in Arizona, which produces more than 50 percent of United States production. Arizona produces approximately 100 million tons of copper mill tailings per year. Utah ranks second with over 30 million tons of tailings per year. Mines and concentration plants in Michigan, Montana, Nevada, New Mexico and Tennessee make up the remainder.

Since most of the large disseminated ore bodies which are the primary source of present production range from 015 to 1.0 percent copper, the tremendous amounts of material which must be processed to produce concentrates approaching the theoretical limits required for the production of 1,205,000 tons of copper can easily be seen. Some typical analyses of copper tailings are shown in Table I.[0169]

## Lead & Zinc

"Occasionally one of these metals[2486] is found in economic quantities in an ore in which the other is lacking or is but a minor constituent; such occurrence is, however, so rare that the localities can almost be counted on the fingers of one hand, e.g., lead in southeastern Missouri, Leadville, Colorado, and Tintic, Utah, and zinc at Mascot, Tennessee Franklin Furnace, New Jersey, and southwestern Wisconsin. The usual ores contain galena [PbS], and sphalerite [ZnS]; many carry important amounts of silver; minor amounts of copper are not uncommon and are usually accompanied by minor quantities of gold; pyrite and pyrrhotite are common associates; carbonates and quartz are the most usual rock-forming gangue minerals, but other gangue associates are legion.

The economic minerals of lead are galena [PbS], cerussite [$PbCO_3$], anglesite [$PbSO_4$], and pyromophite [$3Pb_3(PO_4)_2 \cdot Pb\ Cl_2$]. Galena ores comprise the great majority. There are three general classes: (1) those containing lead alone as an economic metal; (2) lead-zinc ores; (3) lead-silver ores.

Calcite, dolomite, and pyrite are the common gangue minerals of the first two classes, quartz of the third class.

The economic minerals of zinc are sphalerite, smithsonite, [ZnCO], calamine [$ZnSio_3 \cdot Zn\ (OH)_2$], franklinite [$Zn\ Fe_2\ O_4$], willemite and zincite. These are several distinct types of ores. Argentiferous and auriferous zinc sulphides with or without some lead, copper, and iron sulphides in quartzose gangue are typical of the Rocky Mountain deposits. Sphalerite alone or with galena and, usually, with some pyrite in limestone are typical of the Mississippi Valley deposits."

Primary lead-zinc production, mostly from the state of Missouri, amounts to over 5.5 million tons per year, which leaves a residue of over 5 million tons per year of tailings. Tennessee represents the primary source of zinc in the United States with over 20 percent of the national production. Again, the production of 5.5 million tons of ore leads to a residue of over 5 million tons of tailings.

Though an average analysis for all lead mining operations, considering the varying geology of the areas of production, would not be meaningful, analyses typical of Missouri lead mines are shown below:[0169]

Old "Lead Belt" - 52% $CaCO_3$, 40% $MgCO_3$
Joplin District - Predominantly Silica
New "Lead Belt" - 52% $CaCO_3$, 40% $MgCO_3$
Plus Trace Impurities from Flotation and
Residual Lead and Zinc

A fairly typical analysis of tailings from zinc mines in Tennessee is shown as follows:[0169]

Chemical Analysis

| $SiO_2$ | $R_2O_3$ | ZnS | $CaCO_3$ | $MgCO_3$ |
|---|---|---|---|---|
| 9.80 | 1.45 | 0.18 | 52.30 | 36.35 |

Lime equivalent = 95.55

Screen Analysis

| Screen Size | Wt % on Screen |
|---|---|
| +20 | 0.4 |
| +35 | 8.0 |
| +65 | 22.4 |
| +100 | 11.0 |
| +150 | 10.8 |
| +200 | 6.0 |
| -200 | 41.4 |
| Total | 100.0 |

## 3. TOXICOLOGY & ENVIRONMENTAL HAZARDS

Copper, lead and zinc tailings constitute a negligible toxicological hazard. The tailings do, however, constitute a severe environmental problem on the basis of three major elements: (1) the sheer volume of the refuse materials; (2) the dust problems encountered because of the fineness of tailings; (3) the production of acidic, iron containing leachates which may also contain small quantities of flotation reagents.

As an example of the types of leachates which may be produced, mine drainage (similar to the leachate produced from the tailings dumps) from a lead-zinc mine in southeast Kansas contained 1000 ppm of iron at a pH of 2.65.[2485]

## 4. DEFINITION OF PRESENT WASTE MANAGEMENT PRACTICES

Present methods of waste management have evolved around the entrapment of the tailings in ponds and the subsequent stabilization of the dried tailings. As described in the Dames and Moore Engineering Bulletin No. 34, tailing ponds are developed by two basic methods:

"1) Building Retaining Dams.[2484] For this system, earth dams are constructed for retaining the tailings to the planned height. After the dams are completed, the tailings are deposited behind the dams in essentially the same manner as would be used to fill a water reservoir. Such dams are usually designed and constructed to water retention standards.

"2) Build With Tailings. Another system consists of building the dams by using the tailings themselves. A small starter dike is constructed with imported materials on the downstream side of the pond after that, the remaining perimeter embankments are constructed by controlling the hydraulic deposition of the tailings. Such control usually involved adjustments in the decant system of the pond and the use of a limited amount of imported fill. In developing ponds by this system, the various factors influencing water handling and embankment construction must be considered during the entire life of the tailings pond.

The first system--involving the initial construction of earthen retaining dikes--usually results in a high initial investment but low operating costs. The second system--building with tailings--results in a low initial investment, but requires continuing attention during the operation of the facility. Most installations evolve into a combination of the two systems, particularly since the continuous desposition of tailings often requires a larger storage capacity than that available behind the initially constructed retaining dam."

Stabilization of tailings is presently being attempted by one, or combinations of the following methods:

1) Coatings. Some dried tailings areas have been covered with asphaltic or clay coatings to prevent the problems of blowing dust.

2) Chemical Stabilization.[0136] "Chemical stabilization involves reacting mineral wastes with a reagent to form a water- and air-resistant crust or layer. Many reagents have been tested on different tailings. These studies indicated that cement, lime, sodium silicate with $FeSO_4$ and $CaCl_2$ additives, oxidized pyrite or pyrrhotite, various lignin sulfonates, redwood bark extracts, amines, dicalcium silicate, bituminous base products, elastomeric polymers, sulfonated petroleum products, and resinous adhesives were effective stabilizers for most types of tailing wastes."

3) Vegetative Stabilization. Vegetative stabilization consists of providing a vegetative cover that renews itself and provides a suitable habitat for the enroachment of native plant species. This is normally accomplished by planting a mixture of seeds and seedlings native to the area of interest.

Though vegetative stabilization is the most ecologically satisfactory method of stabilization, it is complicated by the fact that most tailings are:[0136]"(1) deficient in certain plant nutrients; (2) unfavorable for plant growth due to textural and structural properties which adversely influence soil aeration and moisture; (3) include unconsolidated sands which, when windblown, tend to sandblast or bury young plants; (4) are light in color and reflect solar radiation to the darker surfaces of plants thus intensifying physiological stresses; (5) contain salts and heavy metal phytotoxicants that adversely affect plant growth."

## 5. CONCLUSIONS

It is apparent that copper, lead and zinc tailings are not "hazardous" materials in a toxological sense, though they are a large environmental problem, and consequently they are not candidates for National Disposal Sites.

However, it is readily apparent that much must be accomplished to make existing and future tailings ecologically acceptable. In the reduction of the environmental problems associated with tailings disposal, the following elements should be considered for research and development as well as the agronomical efforts required for the development of effective vegetative cover at each site. (1) A very inexpensive method of agglomerating tailings is required, both to improve the aeration characteristics of the soil and to improve its tilth; (2) less expensive means of chemically stabilizing tailings while vegetative stabilization is developing would be most useful; (3) one reference[0136] speaks of the advantages of adding sewage sludge to "improve the structure and add organic matter." Many municipalities are in difficult straits in their efforts to dispose of sewage sludge in a non-polluting manner. The development of an integrated system of sludge disposal and tailings stabilization could be most beneficial in many cases in aiding both mining companies and municipalities in solving their environmental problems.

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0169

## TABLE I

## CHEMICAL ANALYSES OF COPPER TAILINGS

| Location | $SiO_2$ | $Al_2O_3$ | $Na_2O$ | $K_2O$ | MgO | CaO | Cu | Fe | Ni | S | $CO_2$ | $TiO_2$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Magna, Utah | 70.8 | 12.0 | 1.0 | 5.1 | 3.9 | 1.7 | 0.10 | 2.7 | 0.002 | 0.95 | 0.23 | 0.35 |
| Hayden, Arizona | 81.33 | 8.50 | 0.4 | 4.0 | 0.86 | 0.14 | 0.115 | 3.75 | --- | -- | -- | .5 |
| San Manuel, Arizona | 67.2 | 13.3 | 1.5 | 6.0 | 1.5 | 1.28 | 0.06 | 2.4 | --- | 1.00 | -- | 0.8 |

# PROFILE REPORT

## Domestic Bauxite Mud (282) and Foreign Bauxite Mud (283)

### 1. GENERAL

Bauxite[1975] is a heterogeneous material composed principally of the aluminum oxide minerals, gibbsite $[Al\ (OH)_3]$,[2492]a trihydrate $[Al_2O_3 \cdot 3_2O]$, and the monohydrates, backmite $[AlO(OH)]$, and diaspore $[HAlO_2]$. Major impurities in the bauxite ores are iron oxides, aluminum silicates, and titanium oxides.

Bauxite is normally refined by The Bayer process. This process involves leaching the bauxite with caustic at elevated temperatures and pressures, followed by the separation of the resulting sodium aluminate solution and the selective precipitation of alumina $[Al_2O_3 \cdot 3H_2O]$.

The residue, or tailings from this process is commonly called "red mud." In the case of some ores, the tailings, "red mud," are further treated to extract the aluminum silicates and the residuals from this process are known as "brown mud."

The alumina is further treated by electrolysis in a molten bath of cryolite $[3NaF \cdot AlF_3]$ to produce primary aluminum.

### 2. ORES, CONCENTRATES AND TAILINGS

The primary bauxite ores of concern are Jamaican, Surinam and Arkansas. "Jamaican ore is a mixture of both trihydrate and monohydrate materials, and this type contains about 50 percent $Al_2O_3$, 1 to 2 percent silica, and 20 to 30 percent iron oxide. The Surinam types is mainly the trihydrate gibbsite usually containing 50 percent or more $Al_2O_3$, 2 to 15 percent silica, and 5 to 15 percent iron oxide."[1975] The Arkansas ores are lower in iron oxides and higher in aluminum silicates since they were formed from the weathering of nepheline syenite.

The concentrate from the processing of the ores is in all cases alumina for further processing to primary aluminum.

Tailings from the process have chemical compositions as delineated below:[0146]

| Bauxite Source | Residue Type | Composition-Percent | | | | | |
|---|---|---|---|---|---|---|---|
| | | $Al_2O_3$ | $Fe_{2-4}$ | $TiO_2$ | $SiO_2$ | $Na_2O$ | CaO |
| Jamaica | Red Mud | 20 | 47 | 6 | -- | 4 | 5 |
| Surinam | Red Mud | 20 | 25 | 10 | -- | 10 | 6 |
| Arkansas | Brown Mud | 9 | 8 | 3+ | 17 | 5 | 40 |

These tailings are all quite fine, indeed one Jamaican red mud sample had an average grain size between 0.5 and 2.0 microns with some agglomerated particles to 10 microns. The Jamaican tailings are normally flocculated by the addition of starch and dewatered by settling in thickeners even so the final residue has a solids content of only 20 percent. The other tailings, though filterable, are also quite fine.

The major areas of production of alumina plant wastes are the lower Mississippi River, on the gulf coast, and in Arkansas. Some 7 million tons of tailings are generated annually in these areas.

## 3. TOXICOLOGY & ENVIRONMENTAL HAZARDS

Bauxite tailings constitute a negligible toxicological hazard. The tailings do, however, constitute a severe environmental problem on the basis of two major elements: (1) the sheer volume of the refuse materials; (2) the dust problems encountered because of the fineness of the tailings when they are finally dewatered.

## 4. DEFINITION OF PRESENT WASTE MANAGEMENT PRACTICE

Bauxite tailings are presently disposed of by collection in tailings ponds (see Section 5. Profile Report on Copper [275, Lead and Zinc [276] tailings) or by direct discharge into the Mississippi River.

## 5. CONCLUSIONS

Because of the negligible toxicological effect, bauxite tailings are not considered candidates for National Disposal Sites.

The United States Bureau of Mines[0146] has done considerable work in extracting mineral values from the "red mud" residues. However, the major volume of material will remain to constitute an environmental hazard. In addition to the recommendations for research and development to alleviate the environmental effects contained in the Profile Report on Copper (275), Lead and Zinc (276) , the development of more effective flocculants would be most useful in providing a viable alternative to dumping tailings into the Mississippi River.

## REFERENCES

0146. U.S. Bureau of Mines. Utilization of red mud residues from alumina production. Report of Investigations No. 7454. Nov. 1970. 32 p.

1975. U.S. Bureau of Mines. Mineral facts and problems. Bulletin No. 650, 1970.

2492. Smith, O. C. Identification and qualitative chemical analysis of minerals. New York, D. Van Nostrand Company, Inc., 1946.

# PROFILE REPORT

## Nitroparaffins (309), Nitroethane (303), 1-Nitropropane (311).

## 1. GENERAL

### Introduction

The nitroparaffins treated in this report have all been selected as probable candidates for industrial disposal. These materials are similar in that they are commodity chemicals made by the same process with relatively low toxicity, well-defined and safe methods of industrial handling and common methods of disposal. The nitroparaffins are, therefore, discussed as a class in this report.

### Manufacture and Use[1433,1501]

The major method of manufacture of nitroparaffins is by the reaction of propane with nitric acid in the molar ratio of 1 to 5 at 390 to 400 C and 100 to 125 psi. All four lower nitroparaffins are produced by varying the conditions and the relative amounts can be adjusted somewhat to meet market demands.

$$C_3H_8 + HNO_3 \longrightarrow CH_3NO_2(10\text{-}30\%) + C_2H_5NO_2(20\text{-}25\%)$$

$$+ [CH_3\text{-}CH(NO_2)\text{-}CH_3 + CH_3\text{-}CH_2\text{-}CH_2\text{-}NO_2]\ (55\text{-}65\%)$$

The nitroparaffins are used as intermediates in the production of nitro alcohols, alkanolamines, polynitro compounds, and hydroxylamine and its salts. Other major uses are as cosolvents for polymers, extraction or partition solvents, reaction media, recrystallization solvents and other minor solvent uses. Smaller amounts of nitroparaffins are used in high explosives, as special purpose additives in gasoline and diesel fuels, and as a stabilizer for halogenated alkanes.

### Physical and Chemical Properties

The physical and chemical properties discussed in this report are included in the attached worksheets.

## 2. TOXICOLOGY[0766,1433]

The nitroparaffins are classified by most toxicologists as slightly toxic in marked contrast to the aromatic nitrocompounds. The chief industrial hazard is by inhalation. High concentrations of nitroparaffin vapors produce a mild irritation of the respiratory tract and early symptoms of intoxication such as headache or nausea, which disappear promptly when exposure is reduced. Large doses may cause methemoglobinemia, cyanosis and injury to the liver and kidneys. Repeated skin contact does not cause allergies or other adverse physiological effects.

The Threshold Limit Values (TLV) and maximum allowable concentrations are listed below. The values for the nitropropanes are thought to be very conservative.[1433]

| Nitroparaffins | TVL ppm | TVL $mg/M^3$ | MAC ppm |
|---|---|---|---|
| Nitromethane | 100 | 250 | 100 |
| Nitroethane | 100 | 310 | 100 |
| 1-Nitropropane | 25 | 90 | |
| 2-Nitropropane | 25 | 90 | |

## 3. OTHER HAZARDS[0766,1433,1569]

The mononitroparaffins are relatively stable, but impact under confined conditions can cause explosion of nitromethane. A combination of high temperature and pressure can cause nitromethane to act as a monopropellant. Alkaline solutions of the nitroparaffins should not be reduced to dryness since the metal salts are explosive.

## 4. DEFINITION OF WASTE MANAGEMENT PRACTICES

### Handling, Storage and Transportation

The nitroparaffins are toxic to a certain extent by inhalation and, for this reason, should be handled in a well-ventilated area. Respirators are recommended when necessary. Although accidental contact is not dangerous to the skin, good technique requires that it be kept to a minimum.[0766,1433]

Commercial-grade nitroparaffins are shipped and stored in ordinary carbon steel. However, wet nitroparaffins containing more than 0.1 to 0.2 percent water may become discolored when stored in steel for long periods, even though corrosion of the steel is not excessive. Aluminum and stainless steel are completely resistant to corrosion by wet nitroparaffins.

Storage of nitroparaffins in contact with lead or copper or alloys containing these metals should be avoided. Polymeric materials for gaskets, hoses, etc., should be tested for their suitability before exposure to nitroparaffins.

The commercial nitroparaffins have flash points greater than 100 F and hence require no ICC red label. The ignition temperatures of the lower homologs are relatively high for organic solvents. When ignited, nitromethane burns with a lazy flame, which often dies out spontaneously, and in any case is readily extinguished with water which floats on the heavier nitromethane. The nitropropanes burn more vigorously, but less so than gasoline.

Since nitromethane can explode under conditions of heat, shock and pressure, it preferably should be stored in the 55-gal. drums in which it is shipped. These containers are of light-weight construction so that there is little possibility that they might develop sufficiently high internal pressure either to ignite the nitromethane or to allow it to burn as a monopropellant. Bulk-storage tanks should be isolated, buried, or barricaded to protect them from projectile impacts should an explosion occur in nearby equipment or facilities. With the exception of nitomethane, there are no restrictions on shipment or storage of the lower mononitroparaffins. Nitroethane or the nitropropanes in unconfined quantities have not been exploded by heat and/or shock applied under extreme test conditions.

## Disposal/Reuse

Commercial manufacturers who use nitroparaffins as chemical intermediates, generally reuse all unreacted materials. Manufacturers who use nitroparaffins in various solvents, recycle them indefinitely. When used in explosives or as a fuel, they are completely combusted.

Recommended air and water standards are listed below. The air standard is .01 TLV and the water standard is .01 TLV by weight in 2 liters of water. No standards have been recommended for compounds for which TLV's have not been established.

| Substance | Limit for Air (Man) ppm | Limit for Air (Man) mg/M$^3$ | Limit for Water (Man) ppm or mg/ℓ | Limit for Water (Fish) ppm or mg/ℓ |
|---|---|---|---|---|
| Nitromethane | 1.0 | 2.5 | 12.5 | |
| Nitroethane | 1.0 | 3.1 | 15.5 | 0.01 - 1.0 |
| 1-Nitropropane | 0.25 | 0.90 | 4.5 | |
| 2-Nitropropane | 0.25 | 0.90 | 4.5 | |

## 5. EVALUATION OF WASTE MANAGEMENT PRACTICES

### Option No.1 - Recycling

Presently, manufacturers who use nitroparaffins as solvents or chemical intermediates recycle all possible material. This is the method of choice.

### Option No.2 - Incineration

Unusable nitroparaffins that are unfit for recycling can be incinerated. The incineration of large quantities of material may require $NO_x$ removal by catalytic or scrubbing processes.

## 6. APPLICABILITY TO NATIONAL DISPOSAL SITES

The wastes generated by the industries that use nitroparaffins can be handled on site by recycling and incineration. They should not be considered as candidate waste constituents for National Disposal Sites.

## 7. REFERENCES

0766 Sax. I.R., Dangerous properties of industrial materials, 3d.ed. New York, Reinhold Publishing Corporation, 1968. 1,251 p.

1433 Kirk-Othmer encyclopedia of chemical techtnology. 3d ed. 22 V. New York, Interscience Publishers, 1966.

1492 The Merck index of chemicals and drugs. 7th ed. Rahway, New Jersey, Merck Company, Inc., 1960. 1,634 p.

1501 Faith, W.L., D.B. Keyes, and R.L. Clark. Industrial Chemicals. 3d ed. New York, John Wiley and Sons, Inc., 1965. 824 p.

1569 Manual of hazardous chemical reactions. Boston National Fire Protection Association, 1971. 308 p.

1570 Weast, R.C., ed. Handbook of chemistry and physics. 48th ed. Cleveland, Ohio, Chemical Rubber Company, 1969. 2,100 p.

## HAZARDOUS WASTES PROPERTIES
## WORKSHEET

303

H. M. Name Nitroethane

IUC Name nitroethane

Common Names

Structural Formula

$CH_3-CH_2-NO_2$

Molecular Wt. 75.07 Freezing Pt. -90 C(1) Boiling Pt. 114.0 C(1)

Density (Condensed) 1.052 @ 20/20 C(1) Density (gas) 2.58(1) @

Vapor Pressure (recommended 55 C and 20 C)

15.6 mm @ 20 C(1) @ @

Flash Point 82 F(1)
106 F(2) Autoignition Temp. 778 F(1)

Flammability Limits in Air (wt %) Lower 4.0%(2) Upper

Explosive Limits in Air (wt. %) Lower 3.4%(1) Upper

Solubility

Cold Water 4.5 g/ml(200)(2) Hot Water Ethanol miscible(2)

Others: miscible, methanol, ether;(2) soluble, chloroform, alkaline aq. solution.(2)

Acid, Base Properties

Highly Reactive with

Compatible with

Shipped in

ICC Classification Coast Guard Classification

Comments

References (1) 0766
(2) 1492

309

## HAZARDOUS WASTES PROPERTIES
## WORKSHEET

H. M. Name Nitroparaffins

IUC Name ________

Common Names class of compounds including $C_1$-$C_3$ compounds.

Structural Formula

See 309a, 309b, 303, 311.

Molecular Wt. ________ Melting Pt. ________ Boiling Pt. ________

Density (Condensed) ________ @ ____ ____ Density (gas) ________ @ ____ ____

Vapor Pressure (recommended 55 C and 20 C)

____ @ ____ ____ @ ____ ____ @ ____

Flash Point 103-120 F(1) Autoignition Temp. ____

Flammability Limits in Air (wt %) Lower ________ Upper ________

Explosive Limits in Air (wt. %) Lower ________ Upper ________

Solubility

Cold Water ________ Hot Water ________ Ethanol ________

Others: ________

Acid, Base Properties slightly acidic; salts of inorganic bases may be explosive.(1)

Highly Reactive with ________

Compatible with ________

Shipped in ________

ICC Classification ________ Coast Guard Classification ________

Comments the nitroparaffins are dangerous when heated in confined containers.

References (1) 0766

HAZARDOUS WASTES PROPERTIES
WORKSHEET

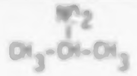
309a

H. M. Name Nitroparaffins

IUC Name 2-nitropropane

Common Names

Structural Formula



$$\overset{NO_2}{\underset{}{CH_3-CH-CH_3}}$$

Molecular Wt. 89.09 Freezing Pt. -93 C(1) Boiling Pt. 120 C(1)

Density (Condensed) 0.992 @ 20/20 C(1) Density (gas) 3.06 @

Vapor Pressure (recommended 55 C and 20 C)

10 mm @ 15.8 C(1) @ @

Flash Point 103 F(1) Autoignition Temp. 802 F(1)

Flammability Limits in Air (wt %) Lower Upper

Explosive Limits in Air (wt. %) Lower 2.6% Upper

Solubility

Cold Water 1.7 Ml/100 ml(2) Hot Water Ethanol miscible(3)

Others: miscible with many organic solvents.(2)

Acid, Base Properties

Highly Reactive with

Compatible with

Shipped in

ICC Classification Coast Guard Classification

Comments

References (1) 0766
(2) 1492
(3) 1570

HAZARDOUS WASTES PROPERTIES
WORKSHEET

309b

H. M. Name Nitroparaffins

IUC Name nitromethane

Common Names nitrocarbol

Structural Formula

$CH_3\text{-}NO_2$

Molecular Wt. 61.04 Freezing Pt. -29 C(1) Boiling Pt. 101 C(1)

Density (Condensed) 1.130 @ 20/4 C(1) Density (gas) 2.11 @

Vapor Pressure (recommended 55 C and 20 C)

27.8 mm @ 20 C(1) @ @

Flash Point 95 F(1) Autoignition Temp. 785 F(1)

Flammability Limits in Air (wt %) Lower Upper

Explosive Limits in Air (wt. %) Lower 7.3% Upper

Solubility

Cold Water 9.10%(2) Hot Water Ethanol soluble(2)

Others: soluble - ether, dimethylformanaide.(2)

Acid, Base Properties

Highly Reactive with

Compatible with

Shipped in

ICC Classification Coast Guard Classification

Comments Forms an explosive sodium salt which bursts into flame on contact with water.

References (1) 0766
(2) 1492

## HAZARDOUS WASTES PROPERTIES WORKSHEET

311

H. M. Name 1-Nitropropane

IUC Name 1-nitropropane

Common Names

Structural Formula

$CH_3-CH_2-CH_2-NO_2$

Molecular Wt.[1] 89.09 Freezing Pt.[2] -108 C(1) Boiling Pt. 132 C(1)

Density (Condensed) 1.003 @ 20/20 C(1) Density (gas) 3.06 @

Vapor Pressure (recommended 55°C and 20°C)

7.5 mm @ 20 C(1) @ @

Flash Point 120 F(1) Autoignition Temp. 789 F(1)

Flammability Limits in Air (wt %) Lower Upper

Explosive Limits in Air (wt. %) Lower 2.6% Upper

Solubility

Cold Water 1.4 ml/100 ml(2) Hot Water Ethanol miscible(3)

Others: miscible with many organic solvents(2)

Acid, Base Properties

Highly Reactive with

Compatible with

Shipped in

ICC Classification Coast Guard Classification

Comments

References (1) 0766

(2) 1492

(3) 1570

# PROFILE REPORT

# AROMATIC NITRO COMPOUNDS

## 4-Nitrophenol (310), 4-Nitrotoluene (312)

## 1. GENERAL

### Introduction

The aromatic nitro compounds treated in this report have been selected as probable candidates for industrial disposal. The materials are similar in that they are commodity chemicals with similar toxicity, well-defined methods of industrial handling and common methods of disposal. These compounds are, therefore, discussed as a class in this report.

### Manufacture and Use[1433]

The aromatic nitrophenols can be made by both direct and indirect routes. However, phenol because of its hydroxyl group is both readily nitrated and oxidized making a nitration by the conventional nitric acid route uneconomical. Consequently, commercial routes utilize indirect two-step procedures. The preferred technique is the hydrolysis of the corresponding nitrochlorobenzene with 15 percent sodium hydroxide at 160 C.

The nitrophenols are used as intermediates in the preparation of dyestuffs, plant sprays (parathion), aminophenols and photochemicals.

The nitrotoluenes are manufactured by the direct nitration of toluene in either batch (liquid phase) or continuous (gas phase) processes. Care must be used to prevent an accumulation of excess nitric acid as this will oxidize toluene reducing the yield and at the same time producing explosive tetranitromethane. A typical product mixture contains 62 to 63 percent *o*-nitrotoluene, 3 to 4 percent *m*-nitrotoluene and 33 to 34 percent *p*-nitrotoluene. The reaction product is washed free of acid and distilled into *ortho*, *meta* and *para* rich fractions.

The nitrotoluenes are used principally in the synthesis of dyes such a as new magenta and turquois blue.

### Physical and Chemical Properties

The physical and chemical properties of the compounds discussed in this report are included in the attached worksheets.

## 2. TOXICOLOGY[0766,1433,1492]

As a class, the nitrophenols are very toxic compounds not only when ingested but also when inhaled or absorbed through the skin. The characteristic effects of poisoning are an enhancement of metabolism with a rise in body temperature, headache, heavy sweating, thirst, fatigue and just before death a sudden rise in body temperature. Chronic exposure is often characterized by hyperthermia, methemoglobinemia, depression, liver and kidney damage, cataracts, eczema, inflammation of the lymphatic glands and degeneration of the nails. The *para*-isomer is the most toxic of the three mononitrophenols.

The toxic properties of the nitrotoluene are similar to those of nitrobenzene but less pronounced. Poisoning can occur by ingestion, inhalation and skin absorption and is characterized by headaches, drowsiness, nausea, vomiting and in severe repeated cases, methemoglobinemia with cyanosis, liver injury and jaundice.

The Threshold Limit Value (TLV) and maximum allowable concentration that have been established are:

| Substance | TLV | | MAC | |
|---|---|---|---|---|
| | ppm | mg/M$^3$ | ppm | mg/M$^3$ |
| *p*-nitrophenol | | | | 4 |
| *p*-nitrotoluene | 5 | 30 | | |

## 3. OTHER HAZARDS

No special hazards other than those mentioned elsewhere in this report are connected with the manufacture and use of these compounds.[0766,1433,1492,1569]

## 4. DEFINITION OF WASTE MANAGEMENT PRACTICES

### Handling, Storage and Transportation[0766,1433]

The nitroaromatic hydrocarbons treated in this report are all very toxic by inhalation, ingestion or skin contact. These materials should only be handled in well-ventilated areas and protective clothing and respirators are recommended where necessary. The toxic nature of these compounds is such that all unnecessary contact with these compounds should be avoided. In case of accidental contact, all contaminated clothing should be removed instantly and the skin washed thoroughly with soap and water. Bicarbonate solutions will help in the removal of the nitrophenols. A change of clothing may be necessary after handling large amounts of these compounds.[0766,1433]

Storage should be in a cool, dry, well-ventilated area, away from acute fire hazards.

These materials are shipped under a variety of U.S. Department of Transportation, Coast Guard and IATA regulations. Since all the compounds treated in this report have flash points above 100 C (212 F), none require ICC warning labels for hazardous chemicals. The primary danger in shipping is due to toxicity and information on safe handling and use of these compounds can be found in the Chemical Data Sheets published by the Manufacturing Chemists Association, standard reference source, or manufacturers Technical Data Sheets.

Recommended air and water standards are listed below. The air standard is .01 TLV and the water standard is .01 TLV by weight in 2 liters of water. No standards have been recommended for compounds for which TLVs have not been established.

| Substance | Limit for Air (Man) | | Limit for Water (Man) | Limit for Water (Fish) |
|---|---|---|---|---|
| | ppm | $mg/M^3$ | ppm or mg/l | ppm or mg/l |
| Nitrophenol | N/A | N/A | N/A | N/A |
| Nitrotoluene | 0.05 | 0.30 | 1.50 | 0.14 |

## Disposal/Use

The manufacture of nitrophenols and nitrotoluenes produces a dilute stream of waste water from a washing or precipitation step. The streams can be either acid or alkaline. A small amount of distillation bottoms is also produced.

The Manufacturing Chemists Association Chemical Data Sheet SD-21 for a nitrobenzene[2479] suggests that small quantities can be disposed of by open burning or as slurry by flushing down the sewer. Disposal of larger quantities by landfill in areas reserved for toxic wastes is suggested.

## 5. EVALUATION OF WASTE MANAGEMENT PRACTICES

### Option No.1 - Treatment of Waste Water to Reduce Biological and Chemical Oxygen Demand

The nitrophenols and nitrotoluenes are biodegradable to acclimated activated sludges. In addition, microorganisms are very sensitive to shock by these compounds and release of abnormal amounts can cause failure of an activated sludge treatment plant.[1543,2479] For these reasons, it is recommended that waste streams be treated on site. Discharge of partially treated waste water should be done only with approval of the local treatment plant and in a continuous manner.

### Option No.2 - Incineration

Contaminated material that can not be reclaimed is best disposed of by controlled incineration. The toxic nature of these compounds requires extreme care to maintain complete combustion at all times. Incineration of large quantities may require the use of a scrubber or thermal device[1435] to control the level of effluent oxides of nitrogen.

### Option No.3 - Flushing Small Quantities Down the Sewer as a Slurry

This alternative is suggested by the Manufacturing Chemists Association for nitrobenzene and would presumably also be applicable to the nitrotoluenes.[2479] It should not be considered as a valid method of disposal since accumulation of nitrotoluene or nitrotoluene vapors in drains and/or sewer could pose a serious hazard to unsuspecting personnel. In addition, insufficient dilution could cause damage to activated sludge sewage treatment plants.

### Option No.4 - Landfill of Large Quantities of Nitrotoluene at Special Toxic Wastes Landfill Sites

This method is suggested by the Manufacturing Chemists Association for nitrobenzene and should also be applicable to the nitrotoluenes.[2479] This method should not be considered feasible because the nitrotoluenes are toxic, mobile and slightly volatile liquids. In addition, their solubility of 100 to 150 ppm in water presents a long-term hazard to underground water supplies.

# 6. APPLICABILITY TO NATIONAL DISPOSAL SITES

Dilute aqueous wastes are best treated on site or in conjunction with municipal sewage treatment systems by conventional biological treatments. Unusable material containing nitrotoluene or nitrophenol is best disposed of by incineration. Incineration should be available at the National Disposal Site for situations where the industry generating the waste can not handle it safely.

## 7. REFERENCES

0766 Sax, I.R., Dangerous properties of industrial materials. 3d ed. New York, Reinhold Publishing Corporation, 1968. 1,251 p.

1433 Kirk-Othmer encyclopedia of chemical technology. 3d ed. 22 v. New York, Interscience Publishers, 1966.

1435. John Zink Company. $NO_x$ destructor. Bulletin No. $NO_x$1071m, Tulsa, John Zink Company. 1 p.

1492 Merck index of chemicals and drugs, 7th ed. Rahway, New Jersey, Merck Company, Inc., 1960. 1,634 p.

1543 Ludzack, F.J., M.B. Ettinger, Journal Water Pollution Control Federation, 32:1173-1200, 1960.

1569 Manual of hazardous chemical reactions. Boston National Fire Protection Association, 1971. 308 p.

2479 Nitrobenzene chemical safety data sheet SD-21. Washington, 1956. 16 p.

310

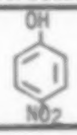
## HAZARDOUS WASTES PROPERTIES
## WORKSHEET

H. M. Name p-Nitrophenol

IUC Name 4-nitrophenol

Common Names

Structural Formula



Molecular Wt.[1] 139.1 Melting Pt.[2] 113-114 C(1) Boiling Pt. 279 C (d)(1)

Density (Condensed) 1.270 @ 120/4 C(1) Density (gas) @

Vapor Pressure (recommended 55°C and 20°C)

@ @ @

Flash Point Autoignition Temp.

Flammability Limits in Air (wt %) Lower Upper

Explosive Limits in Air (wt. %) Lower Upper

**Solubility**

Cold Water 1.6 g/100 ml 25 C(4) Moderate(2) Hot Water 29 g/100 ml 90 C(4) Very(3) Ethanol Very(2)

Others: very, chloroform, ether; addition of base of carbonate to aqueous solutions increases solubility(2)

Acid, Base Properties acidic, $K_a = 7x10^{-8}$

Highly Reactive with

Compatible with

Shipped in

ICC Classification Coast Guard Classification

Comments

References (1) 0766 (4) 1433
(2) 1492
(3) 1570

## HAZARDOUS WASTES PROPERTIES
## WORKSHEET

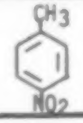
312

H. M. Name p-Nitrotoluene

IUC Name 4-nitrotoluene

Common Names methyl nitrobenzene

Structural Formula



Molecular Wt. 137.1

Melting Pt. 51.9 C(1)

Boiling Pt. 238.3 C(1)

Density (Condensed) 1.286 @

Density (gas) 4.72(1) @

Vapor Pressure (recommended 55 C and 20 C)

1 mm @ 53.7 C(1)

Flash Point 223 F(1)

Autoignition Temp.

Flammability Limits in Air (wt %) Lower Upper

Explosive Limits in Air (wt. %) Lower Upper

Solubility

Cold Water very slightly(2)

Hot Water

Ethanol soluble(2)

Others: soluble, benzene, ether, chloroform, acetone,(2) carbon tetrachloride, carbon disulfide.(3)

Acid, Base Properties

Highly Reactive with

Compatible with

Shipped in

ICC Classification IATA: Poison B, poison label

Coast Guard Classification

Comments

References (1) 0766

(2) 1492

(3) 1570

# PROFILE REPORT

## Slag I (SIC 3331) Copper Smelting (371) and Slag II (SIC 3332) Lead Smelting (372)

## 1. GENERAL

### Introduction

Copper is extracted from ore concentrates by smelting in a reverberatory furnace. The materials may be prepared by drying or roasting or they may be charged directly into the furnace.

The molten charge in the furnace separates into layers of matte and slag. Slag is removed at this point while the molten matte is transferred to converters where silica flux is added and air blown through. Iron sulfide is oxidized and the iron is removed as a silicate slag, while the copper sulfide is converted to blister copper for further refining.

Lead sulfides are converted to oxides of lead and sulfur in the preliminary sintering step. The oxidized material is then reduced in the blast furnace to form impure metal and slag. To form the slag the materials used are limestone, silica, and small amounts of scrap iron. These are added in the amounts required to form a free running slag.

## 2. COMPOSITION

Copper. The two molten products of the reverberatory furnace generally have the following range of values (in percent):[2493]

| Component | Matte | Slag |
|---|---|---|
| Copper | 25-50 | 0.4-0.7 |
| Iron | 29-35 | 34 -40 |
| Silica | 0.8-1.0 | 35 -40 |
| Sulfur | 22-29 | 1.0-1.5 |

Lead. The slag is removed from the blast furnace separately and is conveyed to a fuming furnace for recovery of lead and zinc. As it goes to the fuming furnace the slag contains 10 to 20 percent zinc, one to two percent lead, the remainder is mainly siliceous and contains iron and calcium.

Minor Constituents in Nonferrous Smelting. "Ores and concentrates of copper, zinc, and lead have varying amounts of minor constituents that sometimes require the use of special processing methods to recover them or to overcome or avoid the problems they could cause. There is not only considerable variation in the constituents from one smelter to another, but also from time to time in particular smelters. These constituents include chlorine compounds in lead smelters, fluorine in copper, zinc, and lead smelters, and arsenic in most ores of the western United States. Cadmium is commonly associated with zinc, and the quantities are large enough so that most plants recover it. Mercury is found in some zinc ores and has been recovered in some instances. Bismuth, selenium and tellurium are often present in ores of most nonferrous metals.

Volatile constituents such as arsenic get into the gases and usually deposit in the flue system. One copper smelter has recovered and purified arsenic for sale as a byproduct."[2943]

## 3. TOXICOLOGICAL AND ENVIRONMENTAL HAZARDS

The leachates from slag dumps may present toxicological hazards depending upon the minor constituent metals contained in the slag of interest. The toxicological hazard and the recommended methods of treatment are discussed in the Profile Reports covering the metals of interest. Detailed chemical analysis of slags and leachates from each operation would be required to make a judgement since the feed ore and byproduct recovery are so variable. Slags constitute an environmental problem because of the volume of material produced.

## 4. WASTE TREATMENT METHODS

Slag is generally dumped in the most economical, available area. Some efforts have been made to utilize slags as aggregates in concrete, for road metal etc. but the economic limits for the transportation of these low value products only allows them to be used in the area of the smelters.

## 5. CONCLUSIONS

Because of their volume and their low level toxicological impact slags are not candidates for National Disposal Sites. To alleviate their environmental impact research efforts should be encouraged which will: 1) provide economical extraction of all metal values and 2) improve their acceptability to State Highway Departments and others for use as aggregate and other building products.

## 6. REFERENCE

2493. McKee, Arthur G. and Company. Systems study for control of emissions primary nonferrous smelting industry. v. 1. Final Report under contract QH 86-65-86. San Francisco, Arthur McGee and Company, Western Knapp Engineering Division. June 1969.

# PROFILE REPORT

## Sodium Acid Sulfite (380), Sodium Nitrite (397), Sodium Sulfite (405)

## 1. GENERAL

### Introduction

The inorganic chemicals in this report are basically nontoxic. However, when dissolved in water in sufficiently large quantities they may create a hazard or nuisance. They are grouped together here in one report because they can be handled by similar disposal processes.

### Manufacture and Uses

Sodium Acid Sulfite. Sodium acid sulfite, $NaHSO_3$, is prepared as white crystals or as crystalline powder that has a slight sulfurous odor and a disagreeable taste. It is prepared by saturating sodium carbonate solution with sulfur dioxide gas. The product is obtained as a suspension which is removed from the solution by centrifuging. The dried product is really the sodium metabisulfite, $Na_2S_2O_5$, which yields $N_2HSO_3$ upon solution in water. It finds industrial use either as a solution or as a solid. The solutions may be shipped, stored and handled in lead-lined equipment. In the tanning industry sodium acid sulfite is used as a reducing agent for chrome solutions. In the textile industry it is a bleaching agent, a dechlorinating agent, and a raw material for the manufacture of hydrosulfite solutions. It is also consumed in the paper, photographic and organic chemical industries.[1416,1662]

Sodium Nitrite. Sodium nitrite, $NaNO_2$, is prepared as slightly yellowish or white crystals, pellets, sticks or powder that oxidizes upon exposure to air. In the dye industry sodium nitrite is a very important chemical, used for the diazotization of amines for making azo dyes. It is also used in the preparation of nitric oxide, pickling metal, medicine, rustproofing and cutting oils. Formerly sodium nitrite was prepared by the reaction,

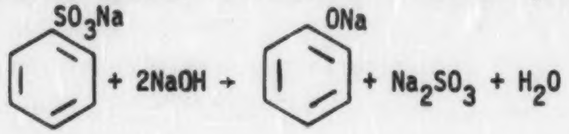
$$NaNO_3 + Pb \rightarrow NaNO_2 + PbO.$$

Now it is manufactured by passing NO, obtained by oxidation of ammonia, into soda ash solution.

$$Na_2CO_3 + 2NO + 1/2O_2 \rightarrow 2\ NaNO_2 + CO_2$$

Sodium nitrate is also formed and is separated from sodium nitrite by crystallization in lead lined equipment.[1416,1662]

Sodium Sulfite. Sodium sulfite, $Na_2SO_3$, is manufactured as white crystals or powder. It is a compound that is easily oxidized. For this reason it is employed in many cases where a gentle reducing agent is desired. It is employed to bleach wool, silk and as an "antichlor" (dechlorinating agent) after bleaching of yarns, textiles, and paper, as a preservative for foodstuff and to prevent raw sugar solutions from coloring upon evaporation. It is also used in photography, medicine and to remove oxygen from boiler water. The most important commercial manufacturing process starts by passing sulfur dioxide into a solution of soda ash until the product is acid. Then sodium sulfite is formed by adding the stoichiometric quantity of soda ash, and boiling until carbon dioxide is evolved. After the carbon dioxide has been evolved, the solution is concentrated, whereupon the crystals of $Na_2SO \cdot 7H_2O$ settle out upon cooling. Another commercial source of sodium sulfite is as a byproduct from the preparation of phenol by the fusion of sodium benzene sulfonate with sodium hydroxide.



Sodium sulfite is also recovered from paper mill cellulose waste liquors.[0955,1416,1662]

## Physical and Chemical Properties

The physical and chemical properties of the inorganic chemicals treated in this report are summarized on the attached worksheets.

## 2. TOXICITY

The materials treated in this report are not highly toxic. However, they are all soluble in water to yield solutions that are corrosive and in high concentrations are irritating to the skin and mucous membranes. Two of the compounds, sodium nitrite and sodium sulfite, are employed as food additives. No Threshold Limit Values (TLV's) have been recommended by the American Conference of Governmental Industrial Hygienists for these compounds.[0225] Sodium nitrite has a lethal dose reported as "or $LD_{50}$ 480 mg/Kg rat".

## 3. OTHER HAZARDS

The three compounds covered by this report are generally considered to be reducing agents. Sodium nitrite, however, is also an oxidizing material that is a fire hazard when in contact with organic or other easily oxidized material. All three compounds are corrosive to most metals and require lead-lined equipment for storage of concentrated solutions.[0955]

## 4. DEFINITION OF ADEQUATE WASTE MANAGEMENT

### Handling, Storage and Transportation

The three materials covered by this report may be handled and stored as strong solutions in lead-lined equipment. Sodium acid sulfite must be protected from air to avoid oxidation. Sodium nitrite is classified by DOT and the Coast Guard as oxidizing material that required a Yellow Label.[0766] The other materials do not have shipping regulations.

### Disposal/Reuse

Industrially contaminated materials covered in this report, when in sufficient quantity, can be reprocessed for reuse. Usually the materials can be purified by recrystallization. Safe disposal of wastes containing these materials is here defined as processes whose effluents meet the provisional recommended maximum exposure limits in water given below.

| Contaminant in Water | Provisional Limit | Basis for Recommendation |
|---|---|---|
| Sodium Acid Sulfite | 24 mg/l | Provisional limit for fish |
| Sodium Nitrite | 45 mg/l as $NO_2$ | Drinking water standard |
| Sodium Sulfite | 0.2 mg/l | Provisional limit for fish |

## 5. EVALUATION OF WASTE DISPOSAL PROCESSES

The disposal of the reducing agents covered by this report is accomplished by diluting the materials with a large volume of water containing soda ash and then adding calcium hypochlorite. The solution is decanted or siphoned into another container if sulfate is present. The solution is then neutralized with 6M-HCl, diluted and discharged into a sewer or stream. The sludge, if any, is added to a landfill. This method is considered satisfactory for the three materials covered by this report.[0095]

## 6. APPLICABILITY TO NATIONAL DISPOSAL SITES

The chemical compounds discussed here have been classified on a preliminary basis as probable candidates for municipal disposal. Based on the disposal process described in Section 5, it may be concluded that waste treatment for these compounds can be handled adequately locally and no consideration for treatment at National Disposal Sites is warranted.

# 7. REFERENCES

0095. Manufacturing Chemists Association. Laboratory waste disposal manual. 2d ed. Washington, 1969. 176 p.

0225. American Conference of Government Industrial Hygienists. Threshold limit values for 1971. Occupational Hazards, 35:35-40, Aug. 1971.

0766. Sax, N. I. Dangerous properties of industrial materials. 2d ed. New York, Reinhold Publishing Corporation, 1957. 1,467 p.

0955. Sitting, M. Inorganic chemical and metallurgical process encyclopedia, Park Ridge, New Jersey, Noyes Development Corporation, 1968. 883 p.

1416. Ross, A. and E. Ross. Condensed Chemical Dictionary. 6th. ed. New York, Reinhold Publishing Corporation, 1961. 1,256 p.

1570. Chemical Rubber Company. Handbook of chemistry and physics. 47th ed. Cleveland, Chemical Rubber Company, 1966. 1,500 p.

1662. Shreve, R. N. Chemical process industries. 2d ed. New York, McGraw-Hill Book Company, 1956. 1,004 p.

## HAZARDOUS WASTES PROPERTIES
## WORKSHEET

H. M. Name Sodium acid sulfite

IUC Name Sodium acid sulfite

Common Names Sodium bisulfite

Structural Formula

$NaHSO_3$

Molecular Wt. 190.11(1) Melting Pt. decomposition(1) Boiling Pt. ______

Density (Condensed) 1.48g/cc @ 20 C(1) Density (gas) ______ @ ______ ______

Vapor Pressure (recommended 55 C and 20 C)

______ @ ______ ______ @ ______ ______ @ ______

Flash Point ______ Autoignition Temp. ______

Flammability Limits in Air (wt %) Lower ______ Upper ______

Explosive Limits in Air (wt. %) Lower ______ Upper ______

Solubility

Cold Water very soluble(1) Hot Water very soluble(1) Ethanol slightly soluble(1)

Others: ______

Acid, Base Properties ______

Highly Reactive with ozidizing materials

Compatible with ______

Shipped in 500 lb barrels; 500-, 600-lb drums; solution in 500-lb barrels(2)

ICC Classification none(2) Coast Guard Classification None(2)

Comments When dried sodium metabisulfite, $Na_2S_2O_5$, is formed(2)

References (1) 1570
(2) 1416

## HAZARDOUS WASTES PROPERTIES
## WORKSHEET

H. M. Name Sodium nitrite

IUC Name

Common Names Diazotizing salt

Structural Formula

$N_aNO_2$

Molecular Wt. 69.01(1) Melting Pt. 271 C(1) Boiling Pt. 320 decomp(1)

Density (Condensed) @ Density (gas) @

Vapor Pressure (recommended 55 C and 20 C)

@ @ @

Flash Point Autoignition Temp.

Flammability Limits in Air (wt %) Lower Upper

Explosive Limits in Air (wt. %) Lower Upper

Solubility

Cold Water 72g/100 g at 0 C(1) Hot Water 163g/100g at 100 C(1) Ethanol slightly soluble(2)

Others: 0.3g/100 g ether at 20 C(1)

Acid, Base Properties

Highly Reactive with Reducing or oxidizing materials(2)

Compatible with

Shipped in 25-, 100-lb drums; 150-lb kegs; 400-lb barrels(2)

ICC Classification oxidizing material(2) Coast Guard Classification oxidizing material(2)

Comments

References (1) 1570
(2) 1416

## HAZARDOUS WASTES PROPERTIES
## WORKSHEET

H. M. Name Sodium sulfite

IUC Name Sodium sulfite

Common Names

Structural Formula

$Na_2SO_3$

Molecular Wt. 126.05(1) Melting Pt. decomposes Boiling Pt.

Density (Condensed) 2.633g/cc @ 15.4 C(1) Density (gas) @

Vapor Pressure (recommended 55 C and 20 C)

@ @ @

Flash Point Autoignition Temp.

Flammability Limits in Air (wt %) Lower Upper

Explosive Limits in Air (wt. %) Lower Upper

**Solubility**

Cold Water 12.54g/100 ml at 0 C(1) Hot Water 28.3g/100 ml at 80 C(1) Ethanol Slightly soluble(1)

Others:

Acid, Base Properties

Highly Reactive with Oxidizing materials

Compatible with

Shipped in 100-,200-lb bags; 234-, 450-lb barrels; 400-lb drums(2)

ICC Classification None(2) Coast Guard Classification None(2)

Comments

References (1) 1570
(2) 1416

# PROFILE REPORT

## Sodium Iodide (395)

## 1. GENERAL

### Introduction

Sodium iodide, NaI, is a white, deliquescent crystalline solid. Sodium iodide is prepared by treating ferroso-ferric iodide (see discussion in Section 5) with sodium carbonate. Iron hydroxide is removed from the reaction product by filtration. The filtrate, which contains the sodium iodide in solution, is concentrated and the sodium iodide recovered by crystallization. Sodium iodide is used in photography, medicine, analytical chemistry, and (in solution) as a solvent for iodine.[1492,1662]

### Physical/Chemical Properties

The physical/chemical properties of sodium iodide are summarized in the attached worksheet.

## 2. TOXICITY

Sodium iodide is generally nontoxic.

## 3. OTHER HAZARDS

Sodium iodide becomes dark if exposed to light due to the liberation of molecular iodine. The toxicity is increased sharply due to the free iodine present.

## 4. DEFINITION OF ADEQUATE WASTE MANAGEMENT

### Handling, Storage and Transportation

Sodium iodide should be protected from moisture and light. There are no other special handling or storage requirements. Sodium iodide is shipped in 25-, 100-and 300-lb drums. There are no DOT shipping regulations covering this material.[1492]

### Disposal/Reuse

Because of economic considerations, iodides are usually recovered for reuse. The methods for recovery are discussed in Section 5. Safe disposal of sodium iodide in water is here defined as processing which meets the recommended maximum provisional limit of 0.33 mg/liter for fish.

## 5. EVALUATION OF WASTE DISPOSAL PROCESSES

Iodine can be recovered from concentrated sodium iodide wastes or waste streams by the processes used to recover iodine from brines. The processes used are discussed in the following paragraphs as Options No. 1 and No. 2.

### Option No. 1 - Silver Iodide Process

Sodium iodide in dilute aqueous solution (either as a waste stream or as diluted concentrated sodium iodide) is reacted with a 2 percent silver nitrate solution in the presence of ferric chloride solution as a coagulant. A wood tub is usually used. The mixed $AgI\text{-}Fe(OH)_3$ precipitate produced by the reaction settles and is treated with concentrated hydrochloric acid to dissolve the iron hydroxide precipitate. Iron scrap is added, forming ferrous iodide and silver metal, the reaction being completed within an hour. The silver is removed by filtration and converted to silver nitrate. The ferrous iodide solution is treated with an oxidant such as chlorine to precipitate the iodine. The iodine is separated and melted under concentrated sulfuric acid; the purified iodine is taken off, freed of residual $H_2SO_4$ and packaged.[1662]

### Option No. 2 - Blow Out Process

A dilute solution containing sodium iodide is acidified with sulfuric acid to a pH under 3.5. The acidified brine is chlorinated and stripped in a n acidproof brick-lined blowing-out tower, by passage through the tower countercurrent to a stream of air. The iodine-laden airstream is then passed through an absorbing tower countercurrent to recirculating dilute sulfuric acid. Sulfur dioxide is added to the sulfuric acid effluent from the tower to reduce the free iodine:

$$I_2 + SO_2 + 2H_2O \rightarrow 2HI + H_2SO_4$$

The iodine is reprecipitated by chlorinating the $HI-H_2SO_4$ liquor. The precipitated iodine is filtered, dried with concentrated sulfuric acid, and heated to melt the iodine, which is taken off, freed of residual $H_2SO_4$, and packaged. This process is in operation in the California oil fields and is a continuous process.[1662] Waste sodium iodide can be sent to plants operating this process, but the process cannot be used economically to treat small batches of sodium iodide.

## 6. APPLICABILITY TO NATIONAL DISPOSAL SITES

Sodium iodide wastes can be treated at plants recovering iodine from brines using the process described in Options No. 1 and 2, or small quantities of sodium iodide contaminated wastes can be accumulated at National Disposal Sites and sold to iodine recovery plant operators for recovery via Options 1 or 2. Because of the value of iodine, it is not anticipated that large quantities of sodium iodide will be sent to National Disposal Sites, but it is anticipated that most wastes will be treated at existing iodine recovery plants or at the point of origin by Option No. 1.

# 7. REFERENCES

1492. Ross, A. and E. Ross. Condensed chemical dictionary. 6th ed. New York, Reinhold Publishing Corporation, 1961. 1,256 p.

1662. Shreve, R. N. Chemical Process industries. 2nd ed. New York, McGraw-Hill Book Company, 1956. 1,004 p.

## HAZARDOUS WASTES PROPERTIES
## WORKSHEET

H. M. Name Sodium Iodide

IUC Name

Common Names

Structural Formula

NaI

Molecular Wt. 149.92

Melting Pt. 651 C(1)

Boiling Pt. 1300 C(1)

Density (Condensed) 3.667g/cc @

Density (gas) @

Vapor Pressure (recommended 55 C and 20 C)

@

@

@

Flash Point

Autoignition Temp.

Flammability Limits in Air (wt %) Lower Upper

Explosive Limits in Air (wt. %) Lower Upper

Solubility

Cold Water 158.7g/100 ml at 0 C

Hot Water 256.8g/100 ml at 100 C

Ethanol slightly soluble

Others:

Acid, Base Properties

Highly Reactive with

Compatible with

Shipped in Drums (2)

ICC Classification None(2)

Coast Guard Classification None(2)

Comments

References (1) 1570
(2) 1492

# PROFILE REPORT

## Sodium Silicates (402)

## 1. GENERAL

### Introduction

The sodium silicates, $Na_2O \cdot X\ Si\ O_2 (X = 2,3,4,5)$, are made by fusing sodium carbonate and silica (sand) in a furnace resembling that used for the manufacture of glass. The reaction that takes place at 1300 C is as follows:

$$Na_2CO_3 + X\ SiO_2 \xrightarrow{\Delta} Na_2\ O \cdot X\ SiO_2 + CO_2$$

The most common commercial silicates are those where X equals 2.0 and 3.2. The product upon cooling forms a clear light bluish-green glass. To make sodium silicate solutions, the product is ground and dissolved in water in a steam injected, pressurized reactor. Alternatively, the melt from the furnace is passed directly without chilling into an open rotary dissolver where solution is effected at atmospheric pressure.

The silicates as 32 to 47 percent solutions find considerable use as adhesives for many kinds of materials, especially plywood and paperboard for corrugated containers. Water glass solutions are also used in detergents, metal cleaning, fireproofing and sizing.[0095,1662]

### Physical/Chemical Properties

The chemical/physical properties of the silicates are summarized in the attached worksheet.

## 2. TOXICITY

The sodium silicates are generally nontoxic. In water, their solutions are strongly basic, corrosive, and will cause irritation to the skin and respiratory system.[1662]

## 3. OTHER HAZARDS

When dissolved in water, the silicates are strongly alkaline and will attack aluminum.

## 4. DEFINITION OF ADEQUATE WASTE MANAGEMENT HANDLING

### Storage and Transportation

Solutions of the silicates, due to their alkalinity, attack aluminum. There are no other special handling and storage problems. The silicates may be shipped in solution in drums or dry in bags or fiber drums. There are no DOT shipping regulations covering the silicates.[0766]

### Disposal/Reuse

Industrially contaminated materials will probably not be considered for reprocessing for reuse based on economic considerations. Safe disposal of silicates in water is here defined as processes whose effluents meet the maximum provisional recommended limit of 240 mg/liter as $SiO_2$ for fish.

## 5. EVALUATION OF WASTE DISPOSAL PROCESSES

The disposal of the sodium silicates is both simple and effective. The silicates are dissolved in water, acidified with 6M-HCl and allowed to stand for at least a day. The liquid is decanted into another container, neutralized, diluted, and discharged into a sewer or stream. The sludge (silica gel) is added to a landfill.[0095]

# 6. APPLICABILITY TO NATIONAL DISPOSAL SITES

The sodium silicates have been classified on a preliminary basis as probable candidates for municipal disposal. Based on the disposal process described in Section 5, it may be concluded that waste treatment for the sodium silicates can be handled adequately locally and no consideration for National Disposal Site treatment is warranted.

# 7. REFERENCES

0095. Manufacturing Chemists Association. Laboratory waste disposal manual. 2d ed. Washington, 1969. 176 p.

0776. Sax, N. I. Dangerous properties of industrial materials. 2d ed., New York, Reinhold Publishing Corporation, 1957. 1,467 p.

0955. Sittig, M. Inorganic chemical and metallurgical process encyclopedia, Park Ridge, New Jersey, Noyes Development Corporation, 1968. 883 p.

1492. Ross, A. and E. Ross. Condensed chemical dictionary. 6th ed. New York, Reinhold Publishing Corporation, 1961. 1,256 p.

1662. Shreve, R. N. Chemical process industries. 2nd ed. New York, McGraw-Hill Book Company, 1956. 1004 p.

## HAZARDOUS WASTES PROPERTIES
## WORKSHEET

H. M. Name Sodium Silicates

IUC Name

Common Names Water Glass

Structural Formula

$NaO . XSiO_2$ (X=2,3,4,5)

Molecular Wt. Not a fixed composition      Melting Pt.      Boiling Pt.

Density (Condensed) @      Density (gas) @

Vapor Pressure (recommended 55 C and 20 C)

@      @      @

Flash Point      Autoignition Temp.

Flammability Limits in Air (wt %)      Lower      Upper

Explosive Limits in Air (wt. %)      Lower      Upper

Solubility

Cold Water miscible      Hot Water miscible      Ethanol miscible

Others:

Acid, Base Properties strongly alkaline in aqueous solution

Highly Reactive with Gels form below pH 3 in water

Compatible with

Shipped in Paper bags, drums, tank trucks as solution(1)

ICC Classification None(1)      Coast Guard Classification None(1)

Comments

References (1) 1492

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## PROFILE REPORT

## Taconite Tailings (419)

### 1. GENERAL

The processing of taconite follows the classic extractive metallurgical method of crushing, grinding and separation (in this case by magnetic and hydraulic methods). The concentrates are then mixed with small amounts of clay and pelletized for shipment to the iron smelters while the tailings, approximately two-thirds of the input ore, are left for disposal.

Figure I[2488] shows the flow sheet for the taconite concentration portion of the Reserve Mining Company's operation at Silver Bay, Minnesota, which is fairly typical of todays taconite concentration plants.

### 2. ORES, CONCENTRATES, AND TAILINGS

As described by Aleshin and Schwartz,[0169] taconite ore averages 27 percent iron and 48 percent silica. The Mesabi range of Minnesota is far and away the largest producer in the United States and annually produces some 66 million tons of tailings.

Concentrates contain some 99+ percent of the magnetic iron in the ore and the magnetic portion of the ore constitutes some 70 percent[1975] of the total iron content.

As previously noted, some two-thirds of the original ore is disposed of as tailings. Both coarse and fine tailings are produced by the concentration operation with some 90 percent of the ore being ground to -325 mesh. The tailings contain approximately 8 percent iron and a remainder, which is primarily the original siliceous gangue. "Some lime[0169] (1 lb/ton of tailings solids) or a proprietary cationic flocculating agent (1/8 ppm of pulp ) are currently used to thicken the effluent from the concentrator to about 45 percent solids."

## 3. TOXICOLOGY & ENVIRONMENTAL HAZARDS

Taconite tailings constitute a negligible toxicological hazard. The tailings do, however, constitute a severe environmental problem on the basis of two major elements: (1) the sheer volume of the refuse materials; (2) the dust problems encountered because of the fineness of the tailings.

## 4. DEFINITION OF PRESENT WASTE MANAGEMENT PRACTICE

Taconite tailings are presently disposed of by collection in tailings ponds (see Section 5. Profile Report on Copper [275] Lead and Zinc [276] tailings) or, in one major case, by discharging the tailings into Lake Superior. The discharge into the lake was premised on a phenomenon known as the "heavy density current".[2487] As a result the discharge waters carry the tailings, which are heavier than the surrounding waters, into an area off shore where the lake depth is approximately 900 feet. It is indicated that the density of tailings in the waters discharged is 14,000 milligrams per liter.

## 5. CONCLUSIONS

Because of the negligible toxicological effect, taconite tailings are not considered candidates for National Disposal Sites.

The recommendations for research and development to alleviate the environmental effects contained in the Profile Report on Copper (275), Lead and Zinc (276) Tailings also apply to taconite tailings. The disposal of tailings into bodies of water is presently in litigation questioning the environmental damage caused by this method.

# REFERENCES

0169. ITT Research Institute for the U.S. Bureau of Mines. Techno-economic analysis of mining and milling wastes. Contract No. G6027. 1969.

1975. U.S. Bureau of Mines. Mineral facts and problems. Bulletin No. 650, 1970.

2487. Environmental Reporter. State of Minnesota vs. the reserve mining company. 1972.

2488. Engineering and Mining Journal. Portfolio of flowsheets, June 1969.

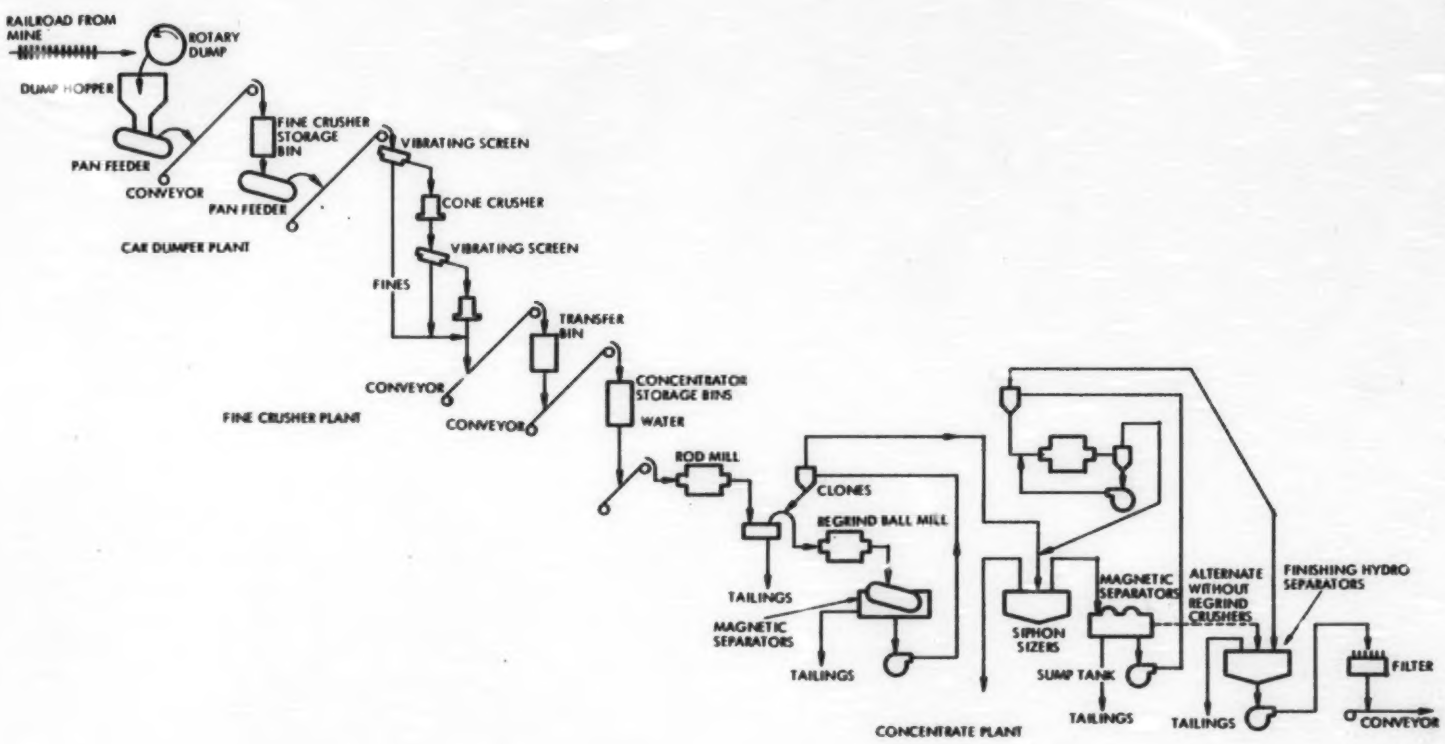
RAILROAD FROM MINE
ROTARY DUMP
DUMP HOPPER
PAN FEEDER
CONVEYOR
FINE CRUSHER STORAGE BIN
PAN FEEDER
CAR DUMPER PLANT
VIBRATING SCREEN
CONE CRUSHER
VIBRATING SCREEN
FINES
CONVEYOR
FINE CRUSHER PLANT
TRANSFER BIN
CONVEYOR
CONCENTRATOR STORAGE BINS
WATER
ROD MILL
CLONES
REGRIND BALL MILL
TAILINGS
MAGNETIC SEPARATORS
TAILINGS
CONCENTRATE PLANT
SIPHON SIZERS
MAGNETIC SEPARATORS
SUMP TANK
TAILINGS
ALTERNATE WITHOUT REGRIND CRUSHERS
FINISHING HYDRO SEPARATORS
TAILINGS
FILTER
CONVEYOR

Figure 1. Reserve Mining Company; Silver Bay Operation

## PROFILE REPORT

## Tricresyl Phosphate (440)

### 1. GENERAL

### Introduction

The common grades of tricresyl phosphate (TCP) are a mixture of *ortho*, *meta*, and *para* or *meta* and *para* isomers. It has been selected as a probable candidate for industrial disposal because it is a relatively high volume commodity chemical which has well-defined and safe methods of industrial handling and disposal.

### Manufacture/Use[1501,1506]

Tricresyl phosphate is manufactured from equivalent amounts of technical cresol with a minimum amount of *o*-cresol, and phosphorus oxychloride by a continuous or batch process. Reaction temperatures range from 150 to 300 C and reaction times from 6 to 9 hours. Hydrogen chloride is removed continuously during the reaction by purging with an inert gas or maintaining the reactor under vacuum.

$$3\ CH_3C_6H_4OH + POCl_3 \longrightarrow (CH_3C_6H_4O)_3PO + 3\ HCl$$

The crude material is washed with hot sodium hydroxide (2%) to remove residue hydrochloric and phosphoric acids, cresol and other impurities, and it is given a final water wash. The material is suitable for use in functional fluids and lubricant additives (45%). A refined grade for use as a plasticizer and flame retardant (45%) is produced by vacuum distillation. For certain applications, trace amounts of cresol are removed by treating the refined material with alkaline permanganate, activated charcoal or zinc and acid. Air filtration media (4%) and miscellaneous applications account for the remainder of the uses. TCP has been replaced as a gasoline additive.

Major manufacturers and plant sites are:[1501,1718]

FMC Corporation, Nitro, West Virginia
Frontier Chemical Corp., Newark, New Jersey
Monsanto Co., St. Louis, Missouri
Stauffer Chemical Co., Point Pleasant, West Virginia

## Physical and Chemical Properties

The physical and chemical properties of TCP are discussed in the attached worksheets.

## 2. TOXICOLOGY[0766]

Most cases of tricresyl phosphate poisoning have followed ingestion, but poisoning by inhalation or skin absorption is also possible. There have been several mass outbreaks of poisoning due to adulteration of food or drink with TCP or the addition of lubricating oils containing TCP to edible cooking oils.

Early symptoms of actual poisoning are transient gastrointestinal upset, nausea, vomiting, diarrhea and abdominal pain. These are followed in one to three weeks by degeneration of the peripheral motor nerves which is manifested by soreness of the lower leg muscles and "numbness" of the toes and fingers. This is followed in a few days by weakness of the toes and bilateral foot-drop. In another week or longer, there may be weakness of the fingers and bilateral wrist-drop. More serious poisoning causes further paralysis and even death by damage to the central nervous system. Sensory changes are completely absent. Recovery is slow and the degree of residual paralysis depends on the degree of poisoning. The order of toxicity for the three isomers is *ortho>>meta>para*.

The Threshold Limit Value (TLV) is:

| TLV | |
|---|---|
| ppm | mg/M$^3$ |
| | 0.1 |

## 3. OTHER HAZARDS

The fire hazard of TCP when exposed to heat or flame is slight, but incomplete combustion or heating to decomposition results in the emission of highly toxic oxides of phosphorus.[0766]

# 4. DEFINITION OF WASTE MANAGEMENT PRACTICES

## Handling, Storage and Transportation

Tricresyl phosphate is a non-volatile, non-corrosive and only slightly flammable liquid that is shipped under no special ICC or IATA regulations.[0766,2351] It is a bulk chemical and is most commonly sold in 1- and 5-gal. metal cans, 55-gal. drums, tank trucks, and tank cars.[2400] Standard safety practices should be observed for storage.[0766]

TCP can be absorbed by the body by inhalation or through the skin, and thus good ventilation should be provided in areas where mists or aerosols may be present. Protective clothing is recommended where necessary. In cases of accidental contact, all contaminated clothing should be removed immediately and the skin washed thoroughly with soap and water.[0766]

## Disposal

The manufacture of TCP results in waste material in the form of semi-solid distillation bottoms which are presently disposed of by landfill. Another byproduct of manufacture is a very dilute aqueous stream (20 ppm) of TCP.[1492] Since this is already less than the provisional standards recommended by TRW for many organic esters and because this stream also contains much higher (100 ppm or more) concentrations of cresol and other phenolics, it is best considered in the Profile Reports on cresol (124) or phenol (327).[1501]

Tricresyl phosphate with a low content of the *ortho*-isomer is used as plasticizer for polyvinyl chloride and acetate polymers and cellulose plastics. It is also used as a flame retardant in polyester, polyurethane and polyvinyl chloride plastics. Items made from these plastics are used in thousands of applications.[1433,2400] Practically none are reused, but disposed of with municipal wastes, either by landfill or incineration.[0690,0604]

TCP is also used as an anti-wear additive in conventional hydrocarbon lubricants as well as an important constituent in special lubricants and hydraulic fluids.[1433] Used, out-of-date, or contaminated fluids are not reprocessed and are usually disposed of by landfill.[0590, 0604]

No recommended air and water standards have been established.

## 5. EVALUATION OF WASTE MANAGEMENT PRACTICES

### Option No.1 - Municipal Disposal of Plastic Material Containing Tricresyl Phosphate

Tricresyl phosphate is used as a plasticizer and flame retardant in the thousands of products that are presently disposed of by municipal landfill and incineration activities. TCP is of such nature that it will not interfere with proper incineration and its low solubility in water (20 ppm)[1492,2400] and great affinity for plastics makes the danger due to underground water leaching very small.

### Option No.2 - Landfill of Heavy Distillation Bottoms from Manufacture

Refined TCP is produced by distilling technical material under vacuum. The chemical composition of the distillation bottoms is similar to TCP except that it is of higher molecular weight. Thus its solubility should be much less than that of TCP, particularly if it is absorbed in plastic material before disposal. Therefore, landfill of this material does not present any excessive long-term hazard to underground water supplies.

### Option No.3 - Landfill of Contaminated or Used Hydraulic and Lubricating Fluids

TCP is used as a lubricant and hydraulic fluid additive as well as being a major constituent in many synthetic lubricants and special purpose liquids. In these applications, small amounts are used at many scattered sites. These fluids are periodically changed due to breakdown, contamination, equipment failure or routinely in critical applications. Their exact fate is not known but it is generally thought that most material is landfilled at local municipal sites. The small amounts landfilled along with the low solubility of TCP (20 ppm)[1492,2400] presents no excessive long-term hazard to underground water supplies.

### Option No.4 - Recycling of Spent Fluids Containing Tricresyl Phosphate

Although it is only partially feasible at present, the best method of disposal of fluids containing TCP is by recycling or downgrading the application. In applications that require very high standards such as aircraft fluids, they are changed regularly for safety reasons. In addition, unused fluids are often discarded because of prolonged storage. Although unsuitable for aircraft applications, they may still be premium fluids for applications requiring lesser standards. Many other fluids have only been slightly degraded and minimal reprocessing may upgrade them for reuse.

## 6. APPLICABILITY TO NATIONAL DISPOSAL SITES

All of the wastes generated in relation to the production and use of TCP can be handled locally by landfill when present in low concentration and by incineration. In addition, the feasibility of recycling certain fluids containing TCP should be investigated. It should not be considered a candidate for the National Disposal Sites.

## 7. REFERENCES

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1501 Faith, W.L., D.B. Keyes, and R.L. Clark. Industrial chemicals. 3d ed. New York, John Wiley and Sons, Inc. 1965. 824 p.

1506 Oil, paint and drug reporter profiles. New York, Schnell Publishing Company, Inc. 1970.

1570 Weust, R.C., ed. Handbook of chemistry and physics. 48th ed. Cleveland, Ohio, Chemical Rubber Company, 1969. 2,100 p.

1718 Synthetic organic chemicals, U.S. production and sales. U.S. Government Printing Office, Washington, D.C., Publication TC-479, 260 p.

2351 Baskin, A.D., Handling guide for potentially hazardous commodities, Chicago Railway Systems and Management Association, 1972.

2400 Product data sheet for tricresyl phosphate. New York, Stauffer Chemical Company. 2 p.

440b

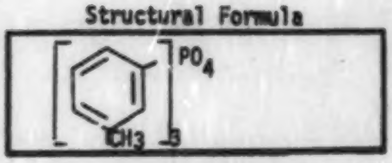
## HAZARDOUS WASTES PROPERTIES
## WORKSHEET

H. M. Name Trycresyl phosphate

IUC Name tri-3-tolyl phosphate

Common Names

Structural Formula



Molecular Wt. 368.37 Melting Pt. 25-26 C(1) Boiling Pt. 258-263 C (4 mm)(1)

Density (Condensed) 1.150 @ 25 C(1) Density (gas) @

Vapor Pressure (recommended 55 C and 20 C)

≃ 4 mm @ 260 C(1) @ @

Flash Point 410 C(2) Autoignition Temp.

Flammability Limits in Air (wt %) Lower Upper

Explosive Limits in Air (wt. %) Lower Upper

Solubility

Cold Water insoluble(1) Hot Water <20 ppm at 85 C(2) Ethanol slightly(1)

Others: soluble ether.(1) most organic solvents.(2)

Acid, Base Properties neutral

Highly Reactive with

Compatible with

Shipped in

ICC Classification Coast Guard Classification

Comments

References (1) 0766
(2) 1492

## HAZARDOUS WASTES PROPERTIES WORKSHEET

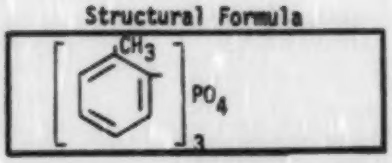
440a

H. M. Name Tricresyl phosphate

IUC Name tri-2-tolyl phosphate

Common Names o-tolylphosphate

Structural Formula



Molecular Wt. 386.34 Melting Pt. -25 to -30 C(1) Boiling Pt. 410 C(1)

Density (Condensed) 1.17 @ 20 C Density (gas) 12.7(1) @

Vapor Pressure (recommended 55 C and 20 C)

17 mm @ ≈ 270-275 C(2) @ @

Flash Point 437 F(1) Autoignition Temp. 725 F(1)

Flammability Limits in Air (wt %) Lower Upper

Explosive Limits in Air (wt. %) Lower Upper

Solubility

Cold Water insoluble Hot Water Ethanol slightly

Others: soluble-ether, chloroform, benzene(3) slightly-hexane, ligroin(3)

Acid, Base Properties neutral

Highly Reactive with

Compatible with

Shipped in

ICC Classification Coast Guard Classification

Comments

References (1) 0766
(2) 1501
(3) 1570

440c

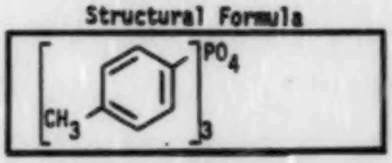
## HAZARDOUS WASTES PROPERTIES WORKSHEET

H. M. Name Tricresyl phosphate

IUC Name tri-4-tolyl phosphate

Common Names

Structural Formula



Molecular Wt. 368.37 Melting Pt. 77-78 C(1) Boiling Pt. 244 C (3.5 mm)(1)

Density (Condensed) 1.247 @ 25 C(1) Density (gas) @

Vapor Pressure (recommended 55 C and 20 C)

3.5 mm @ 244 C(1) @ @

Flash Point 410 C(2) Autoignition Temp.

Flammability Limits in Air (wt %) Lower Upper

Explosive Limits in Air (wt. %) Lower Upper

Solubility

Cold Water <20 ppm(2) Hot Water <20 ppm at 85 C(2) Ethanol slightly(1)

Others: soluble ether, chloroform, benzene(1) most organic solvents.(2)

Acid, Base Properties neutral

Highly Reactive with

Compatible with

Shipped in

ICC Classification Coast Guard Classification

Comments

References (1) 0766
(2) 1492

## HAZARDOUS WASTES PROPERTIES
## WORKSHEET

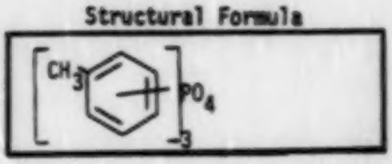
440

H. M. Name Tricresyl Phosphate*

IUC Name tritolyl phosphate

Common Names TCP, Lindol, Celluflex, Kronitex, Phosplex

Structural Formula



Molecular Wt. 368.36 Pour Pt. -28 C(1) Boiling Pt. ≈265 C(10mm)(1)

Density (Condensed) ___ @ ___ ___ Density (gas) ___ @ ___ ___

Vapor Pressure (recommended 55 C and 20 C)

___ @ ___ ___ @ ___ ___ @ ___

Flash Point 455 C(3) Autoignition Temp. 655 C(3)

Flammability Limits in Air (wt %) Lower ___ Upper ___

Explosive Limits in Air (wt. %) Lower ___ Upper ___

Solubility

Cold Water <<0.002% Hot Water <.002% at 85 C(1) Ethanol ___

Others: miscible with all common organic solvents(1)

Acid, Base Properties neutral, commercial material may have traces or cresol.

Highly Reactive with ___

Compatible with ___

Shipped in ___

ICC Classification ___ Coast Guard Classification ___

Comments *Commercial material is a mixture of the three isomeric tritoyl phosphates, usually excluding as much as possible of very toxic *ortho*-isomer.(1) Decomposes to highly toxic fumes of phosphorus oxides.(2)

References (1) 1492
(2) 0766
(3) 2400

# PROFILE REPORT

## Sulfur Mustard(543)

Sulfur mustard, bis(2-chloroethylene) sulfide, is a heavy, oily liquid. It has very little odor in the pure state, but the technical material smells strongly of mustard or horseradish. There are three types of technical mustard: H, HD and HT. H is the symbol for mustard made by the Levinstein process and contains up to 25 percent impurities by weight The impurities are chiefly sulfur, organo-sulfur-chlorides, and polysulfides. HD is mustard that has been purified by washing and vacuum distillation. HT mustard is a mixture of 60 percent HD and 40 percent bis-beta chloroethyl thioethyl ether, $(ClC_2H_4SC_2H_4)O$, formulated to lower the freezing point to 32 F.

Technical mustard is manufactured by the Levinstein process which consists of bubbling dry ethylene into sulfur monochloride at approximately 35 C. Some mustard from a previous batch is usually left in the reactor. The simplified reaction is

$$S_2Cl_2 + 2CH_2{:}\ CH_2 \rightarrow (ClCH_2CH_2)_2S + S$$

After the mustard is made it is allowed to settle for a while to permit some of the impurities to settle out. The resultant material is a light brownish material.

The physical/chemical properties for bis(2-chloroethyl) sulfide are summarized on the attached worksheet.

## 2. TOXICOLOGY

Sulfur mustard is a persistent and powerful blister agent. Both liquid and vapor cause intense inflammation which may blister the skin or mucous membrane with which they come in contact. Mustard acts first as a cell irritant and finally as a cell poison on all tissue surfaces contacted. The first symptoms of mustard poisoning usually appear in four to six hours. The higher the concentration, the shorter the interval of time between exposure and the first symptoms. The physiological action is both local and general. Exposure results in conjunctivitis, erythema followed by blistering and ulceration, and inflammation of the nose, throat, trachea, bronchi and lung tissue.[0778,0952] The effects of sulfur mustard vapors as functions of time and concentration are summarized below:[2442]

Median lethal dosage

| | |
|---|---|
| Inhalation | 1,500 mg-min/m$^3$ |
| Skin absorption (masked personnel) | 10,000 mg-min/m$^3$ |

Median incapacitating dosage

| | |
|---|---|
| Eye injury | 200 mg-min/m$^3$ |
| Skin absorption (masked personnel) | 2,000 mg-min/m$^3$ |

Elevated temperatures and high humidity increase the casuality effect of HD. Slight eye injury can result from dosages as low as 50 to 75 mg-min/m$^3$. Susceptibility varies with individuals. Injuries produced by mustard heal more slowly than thermal burns, and are more liable to infection. The rate of detoxification is very low. Even very small repeated exposures are cumulative in their effects, or are more than cumulative due to sensitization.[2442]

Sulfur mustard is readily absorbed by rubber and leather. When working with mustard special protective clothing and ointments are required.

Sulfur mustard and mustard contaminated wastes should be handled only by an experienced decontamination team, equipped with impermeable protective clothing and air supplied gas masks. The protective clothing should constitute a total body shield.

The American Conference of Industrial Hygienists has not established a Threshold Limit for sulfur mustard but a maximum allowable concentration of 5 x $10^{-2}$ ppb has been recommended for an 8-hr working day.[9225,0778]

The saturation concentration for sulfur mustard is 0.6 mg per liter. This indicates that it will have a good persistency, in fact it is the most persistent of the usable chemical warfare agents.[0778,0952] Heavily splashed liquid persists 1 to days under average weather conditions, and a week or more under very cold conditions.[2442]

## 3. OTHER HAZARDS

Impure sulfur mustard usually contains water and hydrochloric acid which has a corrosive effect on iron and steel. The iron salts formed promote continued corrosion. In addition decomposition products from the mustard form which include hydrogen, hydrogen sulfide, and acetylene. A pressure rise is possible in closed containers, shells, bombs, and transportation containers. Corrosion inhibitors and antioxidation agents are usually added to sulfur mustard.[0778]

Sulfur mustard is shipped under DOT regulations for a Poison, Class A. It is accepted for shipment by freight but not express.[0776]

## 4. DEFINITION OF ADEQUATE WASTE MANAGEMENT

Sulfur mustard released to the environment in air, either inside or outside the plant boundaries, should not exceed $5 \times 10^{-3}$ ppb, one-tenth the recommended maximum exposure for an 8-hr working day.[0778] The Surgeon General, Department of the Army, has established a maximum, permissible concentration for sulfur mustard in drinking water of 2 mg per liter.[0778] It is recommended that the concentration of aqueous effluents containing sulfur mustard not exceed the concentration of 2 mg per liter.

Decontaminants employed include bleach, M5 ointment, fire or DS2 (70 percent diethylenetriamine, 28 percent ethyleneglycolmonomethyl ether, and 2 percent NaOH).

## 5. EVALUATION OF CURRENT AND NEAR FUTURE DISPOSAL PROCESSES

### Option No. 1 - Chlorination

Sulfur mustard added to 10 percent calcium hypochlorite solution is decomposed according to the following equation:

$$S(CH_2CH_2Cl)_2 + 7\ Ca(OCl)_2 + 2\ Ca(OH)_2 \rightarrow CaSO_4 + 8\ CaCl_2 + 4CO_2 + 6H_2O$$

Thus 7.0 pounds of $Ca(OCl)_2$, which contains 0.7 pounds of CaO equivalent to 0.93 pounds of $Ca(OH)_2$, are theoretically required to detoxify one pound of sulfur mustard. Some mustard sulfone may be formed in accordance with the following reaction:

$$2CaCl(OCl) + (ClCH_2CH_2)_2\ S \rightarrow 2CaCl_2 + (ClCH_2CH_2)_2SO_2$$

Mustard sulfone produces severe burns if left on the skin. In practice, therefore, 1.2 times the required amount of $Ca(OCl)_2$ is used. The decontamination is conducted in a closed system where all air leaving the system is scrubbed through $Ca(OCl)_2$ solution and filtered. The salts formed upon detoxification are placed in a landfill after evaporation of the water.[0778] This treatment process is used to treat sulfur mustard that is excess, contaminated or loaded in surplus munitions.

### Option No. 2 - Incineration (Transportable Disposal Site)

The Transportable Disposal System which is described in the Profile Report on Organophosphorus Nerve Agents (287,288) can be applied to munitions or tanks containing sulfur mustard in concentrated form. The sulfur mustard may be dissolved in gasoline and the gasoline solution incinerated. The combustion products will be carbon dioxide, water, sulfur oxides, and hydrogen chloride which are removed by alkaline scrubbing.

## 6. APPLICABILITY TO NATIONAL DISPOSAL SITES

The extreme hazards to man associated with sulfur mustard require that surplus, scrap, or obsolete sulfur mustard and munitions containing sulfur mustard be disposed of at National Disposal Sites operated by the U.S. Army. Option 2 is recommended for disposal of sulfur mustard in concentrated form or for disposal of sulfur mustard in munitions.

# 7. REFERENCES

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0952. U.S. Army. Demilitarization of toxic munitions at U.S. Army Material Command installations, Environmental Statement PB 203-509. Edgewater Arsenal, Maryland, Department of the Army Headquarters, Edgewater Arsenal, 1971.

2442. Department of the Army Technical Manual TM3-215/Department of the Air Force Manual AFM 3557. Military Chemistry and Chemical Agents. Departments of the Army and the Air Force, Washington. December 1963 101 p. (Changes C1 and C2, 16 March 1965 and 15 June 1967).

## HAZARDOUS WASTES PROPERTIES WORKSHEET

H. M. Name Sulfur Mustard

IUC Name 2,2' dichlorodiethylsulfide

Common Names H, HD

Structural Formula

$(ClCH_2CH_2)_2S$

Molecular Wt. 159.08(3)    Melting Pt. 13.5 C(1)    Boiling Pt. 227.8 C(3)

Density (Condensed) 1.2741g/cc @ 200(1)    Density (gas) 5.4(air) @ 20 C(3)

Vapor Pressure (recommended 55 C and 20 C)

0.05 torr @ 10 C(1)    0.1 torr @ 20 C(1)    0.2 torr @ 30 C(1)

Flash Point 105 C(3)    Autoignition Temp. ____

Flammability Limits in Air (wt %)    Lower ____    Upper ____

Explosive Limits in Air (wt. %)    Lower ____    Upper ____

Solubility

Cold Water 0.8g/1 at 20 C(1)    Hot Water ____    Ethanol absolute miscible(1)

Others: ____

Acid, Base Properties ____

Highly Reactive with oxidizing agents(1)

Compatible with Most metals of acid impurities are absent(1)

Shipped in Steel or aluminum containers

ICC Classification Poison, Class A(2)    Coast Guard Classification Poison, Class A(2)

Comments Decomposition temperature 149 to 177 C(3)

References (1) 0778
(2) 0776
(3) 2442